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MAINTENANCE AND REPAIR OF STEEL FREIGHT CARS.

BALTIMORE & OHIO RAILROAD.

Synopsis.

The Growing Demand for Steel Freight Cars.

Railroads in the coal and ore districts have been using steel hopper and gondola cars for a number of years with very satisfactory results. Generally speaking, the roads which do not have a specially heavy traffic of this kind have continued to use either all-wood gondolas and hoppers, or cars with steel underframes and wooden bodies. The gradual but steady increase in the price of lumber and the difficulty in getting a sufficient quantity of a satisfactory quality have caused a number of roads, that formerly used wooden equipment exclusively, to consider seriously the introduction of steel cars and, in some instances, to order a small number of these cars as an experiment.

It is interesting to note that although the prices of steel and lumber have fluctuated considerably during the past ten years, the movement of the price of lumber has practically always been upward, while an increase in the price of steel has usually been followed after an interval by a reduction, and therefore, if the merits of the all-steel and the wooden car are considered from a standpoint of first cost only, it will probably be only a comparatively short time before the steel car can be purchased as cheaply as the wooden car. The steel car, from the standpoint of maintenance and repairs, has, however, many advantages over the wooden car, as may be seen from a careful study of this article. It also, of course, has advantages as concerns service and operating requirements, but no attempt will be made to consider these at this time.

In considering the introduction of steel cars the motive power officer is confronted with two problems. The first one is: What facilities will have to be provided for repairing and maintaining these cars? The second: What is the probable life of a steel car? The purpose of this article will be to answer these two questions, as far as possible, from the experience of the Baltimore & Ohio Railroad. The problem of maintaining and repairing steel cars is a simple one and can best be demonstrated by a visit and a few days' study of the question at a large steel car repair point. It is hoped, however, that by describing the facilities required for this work and a number of typical repairs which are being made the reader may obtain a clear conception of how it is handled.

The Life of the Steel Car.

It is practically impossible to damage a steel car so badly that it cannot be repaired to advantage. This may readily be seen by the data in the following section, showing that of over 23,000 all-steel cars on the Baltimore & Ohio, a large number of which have been in service for as long as eight years, only eleven have been destroyed. Three of these were destroyed on the Baltimore & Ohio, shortly after steel cars were first introduced, on account of the salvage being picked up and scrapped, instead of being diverted to the repair station for reassembling. The others were destroyed on foreign lines, and it is safe to say that probably all of them could have been repaired to advantage with the present knowledge of and facilities for repairing steel cars.

A great deal has been said in a general way concerning the corrosion of steel cars and various authorities have estimated that the sheets in these cars would last from seven to twenty years or more. As a matter of fact very little exact data has been presented. The first modern steel cars which were introduced on the Baltimore & Ohio in 1899 were equipped with floor and side sheets about 3/16 of an inch thick. These cars have been in continuous service since that time, the hopper cars being used very largely for carrying bituminous coal, and yet instances are very rare of the sheets being seriously damaged by corrosion, except where flat bottom cars are held under load for long periods with high sulphur bituminous coal and subjected to rains and the resulting effect from the mild sulphuric acid which is formed. The greater number of these cars have not been entirely re-painted during the eight years and the physical conditions on the Baltimore & Ohio are less favorable for equipment of this kind than on many other railroads. On certain portions of the road there are a great many tunnels and in passing over the mountains there are, of course, many curves. While a number of the earlier cars have been on the repair track, during the past year or two, for heavy repairs, due to weakness in design, there is no record of any of these sheets having to be replaced due to wear or tear, although in a number of instances the cars have been so badly damaged as to require the floor and side sheets to be heated in a furnace to be straightened. If they had been worn to any great extent it would have been very apparent at such times. In a very few instances holes have been found in the sheets, due to corrosion, but such cases

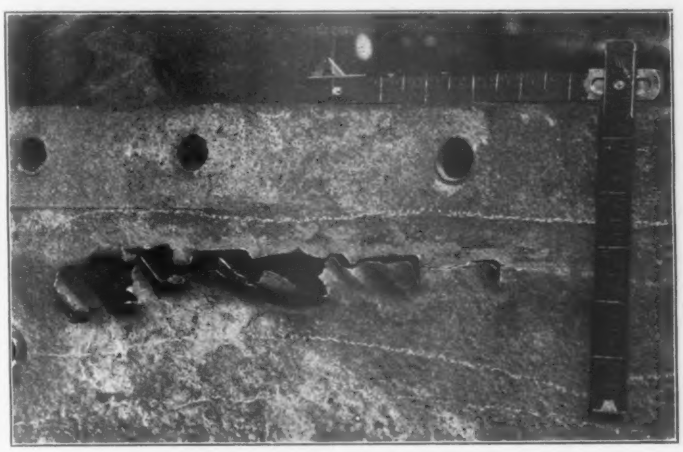

FIG. 1.—CORRODED END SHEET ON A GONDOLA CAR.

are very rare and were apparently not always entirely due to that cause.

During the writer's visit to the Mt. Clare repair yards a gondola car, which had been placed in service in 1899, was brought in for repair of damage due to rough handling. The sheets were found to be very badly corroded, in fact they were stated to be by far the worst that had ever been noticed in the repair yard. The end sheet was eaten through just above the floor sheet, as shown in the photograph, Fig. 1. The only indication was a slight crack and this was opened up by a hammer. The lower edge of the side sheet on these cars is riveted between a flange on the floor sheet and a flange on the end sill and is thus pro-

FIG. 2.—SIDE STAKES INJURED BY CORNERING.

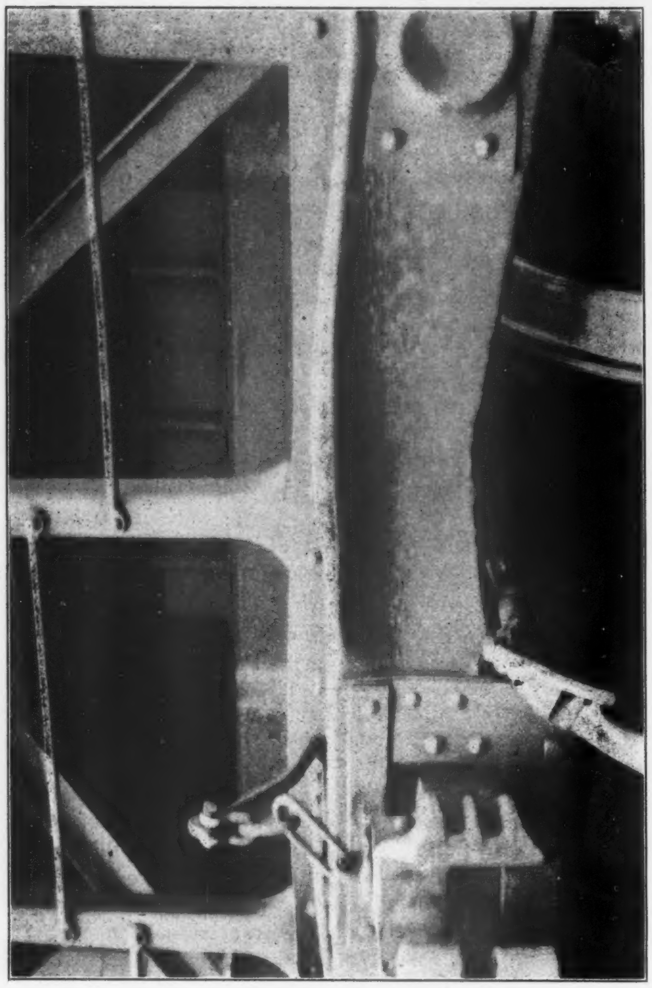

FIG. 3.—BADLY BENT END SILL ON HOPPER CAR.

FIG. 4.—SIDE SILL EXTENSION ON HOPPER CAR DAMAGED.

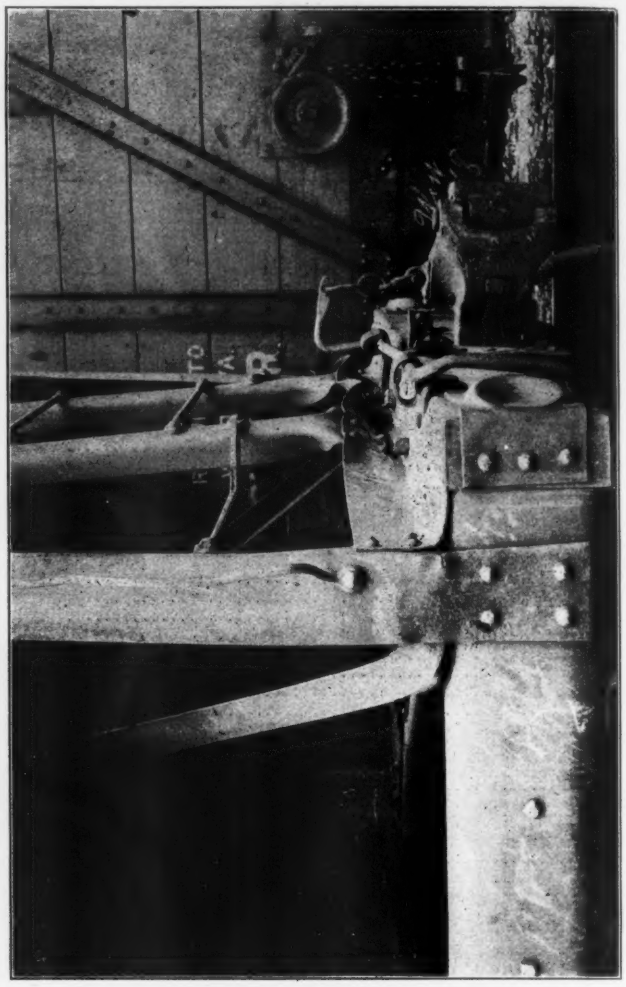

FIG. 5.—UPRIGHTS AND UPPER PART OF END SILL PLATE DAMAGED.

ILLUSTRATIONS OF DAMAGE WHICH WOULD NOT INTERFERE WITH THE OPERATION OF A STEEL CAR, BUT WOULD PUT A WOODEN CAR OUT OF SERVICE.

tected from wear and corrosion, and was therefore in practically the same condition as when it was first erected. An examination of this edge indicated that the sheet was apparently of uneven thickness when it came from the rolls and much less than normal thickness when it was put in place. A heavy coat of rust was found on the floor, side and end sheets, but they were not damaged sufficiently to make it necessary to replace them, and a couple of simple patches on the end sheet was all that was required to put the car in good service condition. The same end sheet was eaten through at the other corner of the car, although the damage was not as bad as on the end shown in the illustration.

As has already been noted, the greatest deterioration found in steel cars occurs when they are out of service and under load with high sulphur bituminous coal. If cars are kept continually in service and under load, the friction between the lading, and the plates on the inside, due to loading and unloading, tends to act as a preserving instead of a deteriorating influence. Cars held under load, out of service, will deteriorate very rapidly, especially during the winter weather, on account of the continuous action of the mild sulphuric acid on the plates. This, of course, applies more to the flat bottom than to the inclined bottom cars. On new equipment ¼ in. side sheets and 5/16 in. floor plates are being applied with a view of overcoming the difficulty, due to corrosion, that is now being experienced in connection with the first all-steel cars. The lower parts of the side sheets of flat bottom all-steel cars, as well as of the hopper cars, and the floor plates of the flat bottom all-steel cars will be the first to give away, and as this occurs the corroded portions will be cut out and patches and angle plates will be applied.

The Baltimore & Ohio has about 7,000 all-steel cars which have been in service since 1899, and although the side and floor sheets on these cars were less than ¼ in. in thickness, probably not more than 3/16, when they were installed, their condition at the present time is such that they will probably give good service for a number of years to come and it is conservatively estimated that the floor sheets will be in fairly good condition after they have been in service for at least twelve years and that the side and end sheets will last for a longer time. The underframes are apparently in practically as good condition as when they were first put in place, and under normal conditions should have a life of at least twenty years. It is estimated that the 5/16 in. floor sheets and the ¼ in. side sheets used on the more recent cars will have a useful life of at least twenty years and the life of the underframe, which is much stronger than that used on the earlier cars, should be twice as long. Where the sides of the car form part of a side girder it is essential that they be sufficiently thick when they are new to allow for corrosive action, depending upon the life that may be desired of the car.

The corrosion is much worse on the inside of the car than on the outside, that on the outside being hardly perceptible, although the cars in some instances had not been re-painted since they were placed in service eight years ago.

The fact that the inside of the car may be covered with a very thick coating of rust does not necessarily indicate that very much metal has been eaten away, as may be seen by the result of some tests recently made by Mr. J. R. Onderdonk, engineer of tests. A piece of rust 5/32 in. thick was analyzed and found to consist of 90 per cent. Fe_2O_3 and 10 per cent. H_2O. In addition slight traces of silicon, calcium and other organic substances were found. The actual thickness of the metal which had been rusted would be .031 in., or about 1/5 of the thickness of the piece of rust.

Apparently the parts which will fail first on the more recent designs of cars having hoppers are the side sheets directly above the hopper doors. When the lading has become frosted, or damp and closely packed, it is the practice to strike the side sheets near the hopper opening in order to loosen it. In some instances the man stands on top of the car, using a hand bar to loosen the lading, and the sloping sheets of the hopper are often struck with these bars, injuring them. These thin spots will probably be eaten through first, but they can easily be patched at a small expense, if necessary.

The Repair Question.

The steel cars are much stronger than the wooden ones and are not so easily damaged. As stated by Mr. J. F. MacEnulty, of the Pressed Steel Car Company, in a paper recently presented before the New England Railway Club, the figures giving the comparative cost of maintenance of steel and wooden cars, as they are ordinarily presented, do not take into consideration the fact that steel cars are seldom damaged to such an extent that they cannot be repaired to advantage, while wooden cars are very often destroyed. The records show that only three Baltimore & Ohio modern steel cars have been destroyed on that system and this would not have occurred under present methods of handling salvage. Eight of their steel cars have been destroyed on foreign lines, but they could undoubtedly have been repaired if the roads upon which the damage occurred had been accustomed to repairing cars of this kind. Of these eight cars one, a hopper, was built in 1902 and was destroyed the same year; a gondola car, which was built in 1901, was destroyed in 1904; three flat cars, which were built in 1902, were destroyed in 1904; a hopper car, which was built in 1899, was destroyed in 1906; and two gondola cars built in 1901 were destroyed, one in 1905 and the other in 1906.

Skilled mechanics are not required to repair these cars successfully. It is the practice on the Baltimore & Ohio to take the men for the steel car repair gangs from among the wooden car repairmen. As will be seen from the section dealing with the facilities provided for repairs, practically no special equipment is required; the cost of the equipment for carrying on this class of work is less than that for the repairing of wooden cars. This applies not only to the tools used by the repairmen, but to the ground space and facilities required for pressing and straightening sheets, etc., as compared with a plant for preparing the timber used on wooden cars.

As far as the repair yard is concerned, it need not be any more extensive or elaborate than would be required to take care of the same number of wooden cars. In the section describing some of the methods used in making typical repairs on the Baltimore & Ohio cars the greater number of defects illustrated are for damage to the earlier cars introduced on the system, which were among the first modern steel cars to be used in large numbers in this country. These designs in the light of present day experience were faulty in a number of respects, due both to the fact that service conditions since 1899 have become very much more severe than could be foreseen at that time, and also to the fact that the development of the design of the modern steel car was very rapid. It is, therefore, not to be wondered at that defects have developed in some of the earlier designs, in fact it is rather surprising that these cars have stood up so well under the severe conditions that they have had to withstand. As may be seen, such defects as have developed may be very readily overcome at a comparatively small expense when the cars come in for repairs.

Liability of Damage to Steel and Wooden Cars.

The steel cars being stronger are not as easily damaged as the wooden ones. Shocks which would seriously damage a wooden car often do not injure the steel car at all, or, if they do, do not render it unfit for service. For instance, in passing through a large freight yard steel cars may be seen that have been damaged by blows which would crush the corresponding part on a wooden car, but which on the steel car are not serious enough to take it out of service for repairs. The accompanying photographs, Figs. 2, 3, 4 and 5, illustrate conditions of this kind.

The first one, Fig. 3, shows an end sill which has been badly bent, but the center of the sill at the coupler is not affected. No attention is paid to defects of this kind, but it may readily be seen that if the end sill of a wooden car had received the same blow it would have been splintered and not only the end sill, but adjacent parts would have been damaged. Fig. 2 shows the results of "cornering," which has torn the side braces, damaging them to some extent, although not enough to warrant re-

FIG. 6.—USEFUL MATERIAL FROM SALVAGE OF FIVE COMPOSITE CARS.

pairing or replacing them. The same blow on the side of a wooden car with outside stakes would undoubtedly have injured some of them so that they would have had to be renewed. Fig. 4 shows the side sill extension on one of the recent types of hopper cars which has been bent in, but not enough to affect the step, hand hold, or push pole casting. Fig. 5 shows the upper part of the end sill plate damaged, also two of the uprights supporting the end of the hopper. Beyond the straightening of the hand hold at the corner no repairs will be required, as the strength of the car has not been materially affected.

In accidents the composite car with steel framing for the body is very little better than the wooden car. As an illustration, the pile of material shown in Fig. 6 is all the useful material that remains of the bodies of five composite cars after the salvage had been sorted out. The sills of these cars are not shown in the illustration, but they consisted of structural steel members and were badly bent, some of them with the flanges of the channels broken. In this connection it is important to note that experience on the Baltimore & Ohio has demonstrated that pressed steel shapes are preferable to rolled shapes. A rolled shape, if the flange is broken, cannot very well be repaired satisfactorily, although this can be done readily with a pressed steel shape. An inferior quality of material can be used in rolled shapes, but first-class material only can be used for sheets which are to be pressed, and if the proper material is not used it is impossible to bend the sheets successfully. The material is such that it can easily be rebent and repaired if it is damaged or bent out of shape. The old argument was that it was better to use structural shapes because they can be obtained readily upon the open market, while the pressed shapes can be obtained only from one source, *i. e.*, the car manufacturer.

Experience to the present time has demonstrated that it is only very seldom that new parts of this kind are required, it being possible to repair practically any defect which may occur. This is clearly shown in the latter part of this article.

A possible justification for building composite cars is where there is a heavy demand for cars which must carry top loads, the wooden sides making it possible to use cleats, and the load can be braced with much less trouble and expense than on a steel car. If the lading in the steel hopper or gondola car, carrying coal or ore, becomes frozen the usual practice is to build a fire under the steel car and thaw it or to dynamite it out. These measures, of course, cannot be used in the case of wooden or composite cars.

Baltimore & Ohio Steel Freight Car Equipment.

The Baltimore & Ohio Railroad was one of the first to introduce extensively the modern type of steel car. For a great many years previous to the advent of the steel car, it had in service and maintained a large number of cars with iron bodies and wooden underframes. One of the first cars of this kind was an iron box car built in 1862. Previous to that time a number of cars were in service for carrying gunpowder, which were similar to an ordinary tank car, but having doors in the ends. These cars were not suitable for general merchandise purposes, and in 1862 and the three or four following years, two or three hundred of these iron box cars were built at the Mt. Clare shops. Their construction and the service they gave are of interest, especially since the first modern all-steel box car has just been built and put in service on the Union Pacific Railroad. (See page 129 of the April issue.)

During the summer months these cars absorbed the heat so that they did not prove very successful for general merchandise purposes. They were afterwards used for hauling lime, but were not an entire success for that purpose as the lime was carried in bulk, and during certain seasons the cars "sweat" and caused trouble by slacking the lime. The accompanying illustrations, Figs. 7 and 8, illustrate the general construction of these cars. The photographs were taken at Locust Point, near Baltimore, where the body of the car is now serving time as a car inspectors' quarters. The two windows at the side have been added since the car was taken out of service and this is also true of some of the patches at the lower edge of the side sheets. The interior view of the car gives a fairly good idea of the side, end and roof construction. The side posts and carlins were of 2 x 2 in. oak. The iron sheets were 1/8 in. in thickness, or about the same as the steel used on the new Union Pacific box car. The bodies of these cars were about 24 ft. long, 8 ft. 2 in. wide at the widest part, and 7 ft. 1 in. high from the lower edge of the underframe to the top of the car. They weighed about 18,000 lbs. The door opening was 4 ft. 10½ in. x 5 ft. The underframe was of wood and the trucks were of the double arch bar type and were equipped with 31 in. wheels.

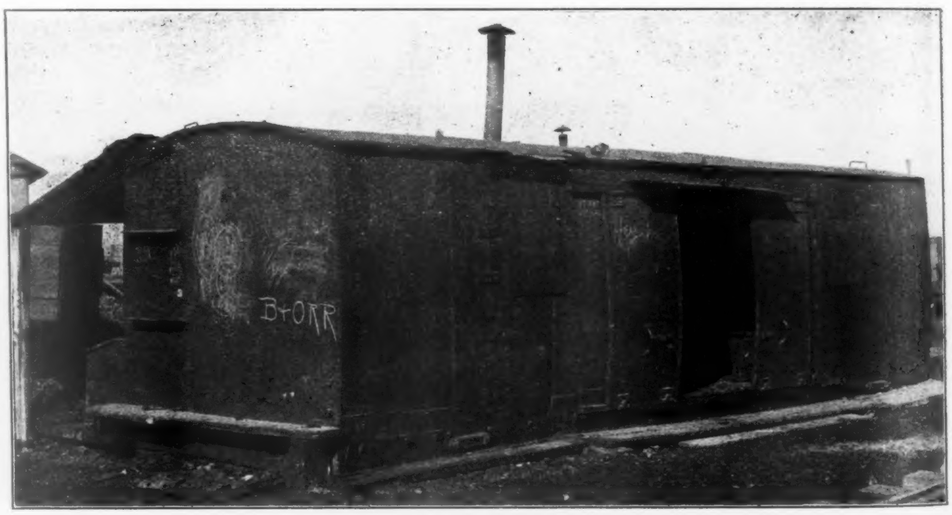

FIG. 7.—BODY OF ONE OF A SERIES OF IRON BOX CARS INTRODUCED ON THE BALTIMORE AND OHIO RAILROAD IN 1862.

In the late seventies or the early eighties a hopper having an iron body and known as the "three pot" hopper was introduced on the Baltimore & Ohio in large numbers. These cars were patented by Ross Winans, and for a long time the Baltimore & Ohio maintained what is known as "the hopper shop" for building them. The earlier cars were of 13 tons capacity, weighing 12,800 lbs., but in 1883 cars of this type of 20 tons capacity

STEEL GONDOLA CARS.

Date built	1899	1901	1906	1906
Class	O-12	O-14	O-17	O-17
Type	Flat bottom with drop doors	Twin Hopper	Twin Hopper	Twin Hopper
No. built	3,000	4,000	1,000	2,000
Road numbers	37,000 to 39,999	40,000 to 43,999	136,000 to 136,999	137,000 to 138,999
Capacity, marked, lbs	80,000	80,000	100,000	100,000
Capacity, maximum, lbs	91,000	91,000	125,000	125,000
Weight, lbs	31,700	33,900	46,300	46,300
Length, inside	34'	34'	40' 6"	40' 6"
Width, inside	9' 2"	9' 2"	9' 3"	9' 3"
Height, inside	3' 10"	3' 10"	4' 2"	4' 2"
Width over sides, extreme	9' 9½"	9' 9½"	9' 10¼"	9' 10¼"
Height, top of rail to top of side	7' 4¼"	7' 4¼"	8' 9/16"	8' 9/16"
Door openings	2' 8½" 3' 1 7/16"	2' 8½" 3' 1 7/16"	2' 10" 2' 10⅞"	2' 10" 2' 10⅞"
Builder	Pressed Steel Car Co.	Pressed Steel Car Co.	Pressed Steel Car Co.	Cambria Steel Co.

In addition to the above equipment there are five hundred and fifty 80,000 lb. capacity cars which were built in 1899 for the Baltimore & Ohio South Western.

STEEL HOPPER CARS.

Date built	1899	1899	1900	1902	1906	1906
Class	N-8	N-9	N-9	N-9	N-10	N-10a
No. built	1,000	2,000	2,000	4,000	1,000	2,000
Road numbers	26,000 to 26,999	20,000 to 21,999	22,000 to 23,999	120,000 to 123,999	124,000 to 124,999	125,000 to 126,999
Capacity, marked, lbs	95,000	100,000	100,000	100,000	100,000	100,000
Capacity, maximum, lbs	110,000	117,000	117,000	117,000	125,000	125,000
Weight, lbs	34,800	36,700	36,700	36,700	43,600	43,100
Length, inside	30' ¼"	30' ¼"	30' ¼"	30' ¼"	31' 6"	31' 6"
Width, inside	8' 8½"	8' 8½"	8' 8½"	8' 8½"	9' 4"	9' 4"
Height, top of rail to top of side	10' 2¾"	10' 7¾"	10' 7¾"	10' 7¾"	10' 7¾"	10' 7¾"
Builder	Schoen-Pressed Steel Car Co.	Pressed Steel Car Co.	Pressed Steel Car Co.	Pressed Steel Car Co.	Pressed Steel Car Co.	Amer. Car & Fdy. Co.
Width over outside, extreme	9' 4¼"	9' 4¼"	9' 4¼"	9' 4¼"	9' 11½"	9' 11½"
Door openings	2' 1" 2' 11¼"	2' 1" 2' 11¼"	2' 1" 2' 11¼"	2' 1" 2' 11¼"	2' 6" 2' 7¾"	2' 6" 2' 7¾"

In addition the present equipment includes 450 cars which were built by the Schoen Pressed Steel Car Co. for the Pittsburg & Western in 1898. These cars are 100,000 lbs. capacity.

were built, weighing 17,050 lbs. The diagram shown in Fig. 9 illustrates the general arrangement and size of the 20 ton capacity cars and explains why they were known as "three pot" hoppers. It is not now known just how many of these cars were built, but the road numbers which they were supposed to cover were from 20,001 to 22,499 for the 13 ton cars and 23,001 to 24,099 for the 20 ton cars. It is understood that some of them are still in service in the Cumberland district, but most of them have been scrapped for many years because of their being unsuitable for modern service.

The first modern steel cars were introduced on the road in February, 1899. The data for the various cars ordered since that time is shown above.

The road also has seven hundred 100,000 lb. marked capacity flat cars which were built in 1902 by the American Car & Foundry Co. These cars weigh 40,600 lbs., are 40 ft. 2 in. long and have wooden floors.

At the present time 23,636, or 28 per cent. of the 84,173 cars owned by the Baltimore & Ohio are of all-steel construction. In addition there are a large number of cars with steel underframes.

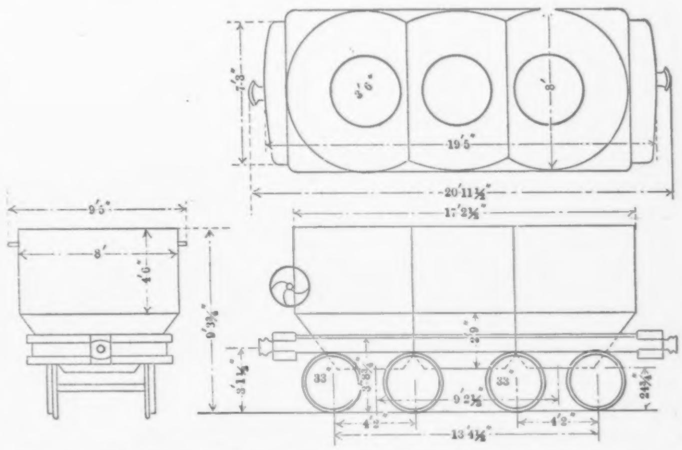

FIG. 9.—20-TON IRON BODY "THREE POT" HOPPER CAR INTRODUCED ON THE BALTIMORE & OHIO IN 1883.

FIG. 8.—INTERIOR OF IRON BOX CAR.

Organization of the Steel Car Repair Department.

As far as supervision is concerned there is no distinction between the steel car and wooden car repair work at Mt. Clare, which is the largest steel car repair point on the system. This work is carried on under the general direction of Mr. John J. Tatum, general foreman of the car department at the Baltimore terminals, who reports to Mr. J. E. Muhlfeld, general superintendent of motive power. The freight car repair work is in direct charge of Mr. J. W. Deible, foreman, and his assistant, Mr. M. V. Pascal. All the repair work is on a piece work basis.

Eight gangs of four men each are required for work on the steel cars. One of these gangs operates the flange fire shop where damaged material is straightened and reshaped. The other seven gangs are engaged in the repair yard. One man in each gang is known as the leader and directs the work of the gang. Each gang usually works on two cars at the same time. When one car is stripped and while the material is being straightened they work on the other car. In some instances after part of the work

has been erected two of the men will drive the rivets on one car while the other two work at stripping another. If there are an unusually large number of steel cars requiring repairs men from the wooden car force are shifted to this work and assist in stripping. On the other hand, if the steel car work is light and the wooden car work heavier than usual men from the steel car gangs are transferred to work on the wooden cars. The men for the steel car gangs are usually selected from the wooden car repair force. That this work does not require what is usually known as skilled mechanics may be gathered from the fact that one of the typical steel car repair gangs is made up of men whose former occupations were as follows: Trolley car conductor, huckster, iron worker and a car repairer from the truck department.

FIG. 10.—VIEW OF THE REPAIR YARD LOOKING EAST, FROM NEAR THE CENTER.

Facilities Provided for Steel Car Repairs.

Yard.—The locomotive shops at Mt. Clare have been extended from time to time so that at present the yard room for the freight car repair department is extremely limited and very much cramped, nevertheless the department is so organized that the work is very satisfactorily handled. That those who are up against the proposition of taking care of steel cars may realize more fully that this work does not require exceptional facilities and may even be done under conditions which would be considered adverse on some roads, the following facts are presented. There are five repair tracks with a material track extending along each side of the yard. These five tracks will accommodate from 17 to 21 cars each, with a space of 15 ft. between the cars requiring heavy repairs. The yard has a total capacity of 100 cars for medium and heavy repairs. The distances between the centers of the repair tracks are as follows: 11 ft. 4 in.; 14 ft. 4 in.; 14 ft. 6 in.; and 15 ft. 6 in.

When the steel car repair work was first started an attempt was made to keep it by itself, but the cramped condition of the yard and the large amount of work which it was necessary to turn out, together with the fact that both classes of work are under the direction of one foreman, made it advisable to put the cars wherever they could be placed to the best advantage, regardless of which type they belonged to. The two photographs, Figs. 10 and 11, taken from a box car in the middle of the yard, one looking east and the other looking west, give an idea of the general arrangement of the yard and the manner in which the steel and wooden car equipment is mixed. That one of the tracks in the view looking west is clear is due to the fact that a number of repaired cars had just been pulled out and the bad orders had not yet been switched in.

Tools.—The tools required are very simple; each gang has a small portable forge for heating rivets; a pneumatic riveter; a pneumatic drill; sledges; chisel bars; ⅝ in. and ⅞ in. drift pins; a pin maul; wrenches and a cold chisel or side cutter for cutting off rivets. The rivets are all cut off with a chisel or side cutter and sledge. A pneumatic hammer was tried for this purpose, but the men who are working on a piece work basis prefer the other method, probably because the steel is light and springs so that the heavy blow of the sledge is more effective than that of the hammer. For lifting the cars, 30-ton, geared jacks are used. These are designed for heavy car and locomotive use, weigh 237 lbs., have a height when down of 27 in., a total rise of bar of 17 in. and a rise of bar of ¼ in. per stroke of the lever.

The department also has ratchet pulling jacks, and what is known as a "box" jack, which is shown in Fig. 12. This last is a relic of the old hopper shop. The screw of the jack is about 3 ft. long, and the housing or standard in which it works is encased in a hard oak box and is backed by an oak plank, as shown. The jack is used for forcing the side sheets outward in erecting and also for straightening bent sheets in place.

Flange Fire Shop.—The flange fire shop, which is shown in Fig. 13, is placed alongside one of the material tracks, and that part of it which is used for steel car work is about 20 ft. wide and 50 ft. long. The frame of the building is partly of wood, although largely of structural steel, and is covered with sheet

FIG. 11.—VIEW OF THE REPAIR YARD LOOKING WEST, FROM NEAR THE CENTER.

FIG. 13.—THE FLANGE FIRE SHOP.

iron. The sides are partially open, as shown. The equipment of this shop consists of an oil furnace, designed and constructed by the railroad, which will take material 10 ft. long and 6 ft. 4 in. wide. The furnace has an opening at one end only, but a new one which has recently been installed at Cumberland has doors at both ends so that long material, such as side and center sills, may be handled in it. A short distance in front of this furnace is an iron face plate 8 ft. 6 in. x 6 ft. 6 in. x 3 in. thick. As may be seen from the illustration, this plate was badly warped and was just about to be replaced by a new one. The screw press flange clamp, which is partially shown at the

FIG. 12.—"BOX JACK" FORCING THE SIDES OF A CAR OUTWARD.

right side of the photograph, is used for clamping and flanging material and will take pieces 11 ft. wide. In addition, the shop is equipped with five formers, two of them for different classes of end sills, one of which is shown directly in front of the four men in the gang; a former for the hopper doors; formers for a side and center sill splice and also for a body bolster diaphragm. Only a few hand tools are required, such as tongs for handling the hot material and the wooden mauls and hammers for straightening the steel. The wooden mauls are of lignum vitæ, 5½ x 10 in., with 4 ft. handles.

The bent side and center sills are heated in a large open fire and straightened in the boiler shop, as the flange fire furnace is not long enough to handle them. Very few new steel parts are required for repairs. Splice plates for the center and side sills are made on the bulldozer in the blacksmith shop, and it is also intended to equip this machine with dies for making the cross braces which are shown in Fig. 24, and are used for stiffening the ends of the earlier types of gondola cars, in place of the angle iron vertical braces with which they are equipped. A 36 in. vertical drill is provided for drilling the holes in the splice plates and braces.

This is about all of the equipment that is required for carrying on the work and is very simple as compared to the tools required by the wooden car repairmen and a wood working shop, and the machine tools required in connection with it. The experience of the Baltimore & Ohio has demonstrated that under ideal conditions very little additional equipment would be required. In planning a new car repair plant to be built in the future, the repair tracks are spaced 20 ft. center to center, with material tracks between every other set of tracks, and possibly with a traveling crane extending over a couple of the heavy repair tracks, to be used largely in handling damaged cars and in taking out cars when repairs are completed. The flange shop will, of course, be considerably larger than the present one and will contain some additional equipment, but otherwise the facilities will not be much more elaborate than those at the present time.

Development in the Design of Steel Cars.

The leading argument advanced by the steel car builders when steel cars were first introduced was that they could be made much lighter than a wooden car of the same strength and capacity, and it was largely for this reason that the railroads decided to use them. It is not surprising, therefore, that some of the parts were made too light on the earlier cars. Due to the strengthening of these parts in the later designs the weight of the steel car has been increased so that, if anything, it is greater to-day than that of the wooden car of the same capacity. The railroads buy these cars not because they are lighter than the wooden cars, but because they are much more satisfactory from an operating standpoint. As the section dealing with typical repairs considers very largely repairs to the earlier classes of cars, it may be of interest to trace the development of those parts which have given the most trouble and show how they have been strengthened in the later cars. One feature of design which has much to do with the stiffening of the car and will greatly prolong its useful life is that the side sheets, which on the earlier cars were only about 3/16 in. thick, have been increased until now they are ¼ in. full. The floor sheets on the more recent cars are 5/16 in. thick. Other features of design, the development of which it will be profitable to study, are the center sills, especially that part between the bolster and the end sill; the body bolster construction and the end sills, more especially as concerns their reinforcement at the center where they come in contact with the coupler horn.

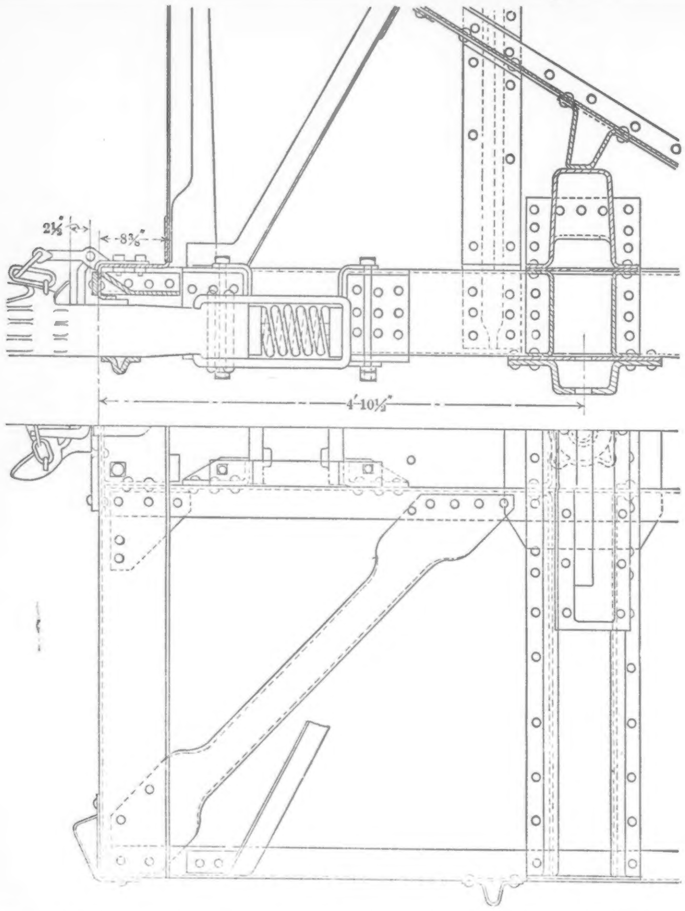

FIG. 14.—BODY BOLSTER, DRAFT SILLS AND END CONSTRUCTION OF THE FIRST ALL-STEEL HOPPER CARS (N-8).

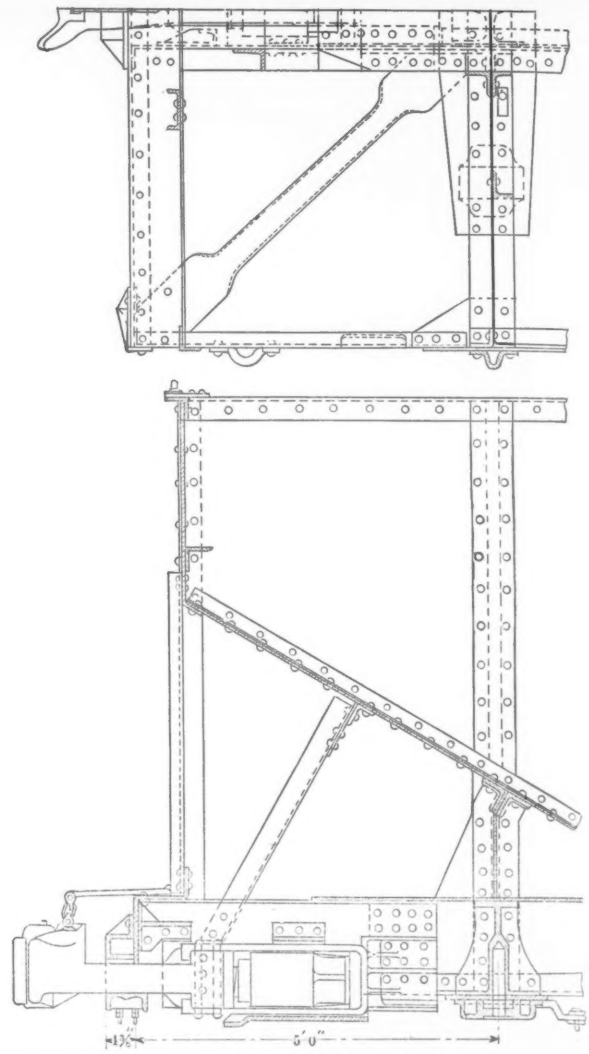

FIG. 16.—BODY BOLSTER, DRAFT SILL AND END CONSTRUCTION OF THE LAST LOT OF STEEL HOPPERS .(N-10 AND N-10A).

Hopper Cars.—These features for the first class of hoppers, N-8, are illustrated in Fig. 14. The center sills are of pressed steel ⅜ in. thick and are continuous the entire length of the car. These cars were equipped with a twin spring draft gear, the draft lugs being of the well-known pressed steel type. As may be seen from the drawing, the center sills are not reinforced between the rear draft lug and the body bolster except by the diagonal braces which extend from the corner of the car to the center sill near the bolster. As the center sill at this point is only 10 in. deep and the flanges are about 4 in. wide the buffing shocks, which are taken entirely by the rear draft lugs, force the sills outward just back of the draft lugs and in many instances have cracked or broken them.

To strengthen the sills at this point and to facilitate making repairs the sills on the second lot of hoppers, N-9, were spliced, as shown on Fig. 15, which also shows an application of tandem spring draft rigging. This draft rigging was applied to about 500 of the N-9 hoppers. The twin spring rigging, or the same as applied to the N-8, was applied to about 1,500 and friction draft gear to about 6,000. The reinforcement, due to the splice, stiffened the sills so that even with the twin spring draft rigging the trouble was considerably reduced, although the construction was still not as strong as might be desired. The construction on the latest hoppers, N-10 and N-10a, which were built in 1906, is very much stronger and it is expected that very little if any

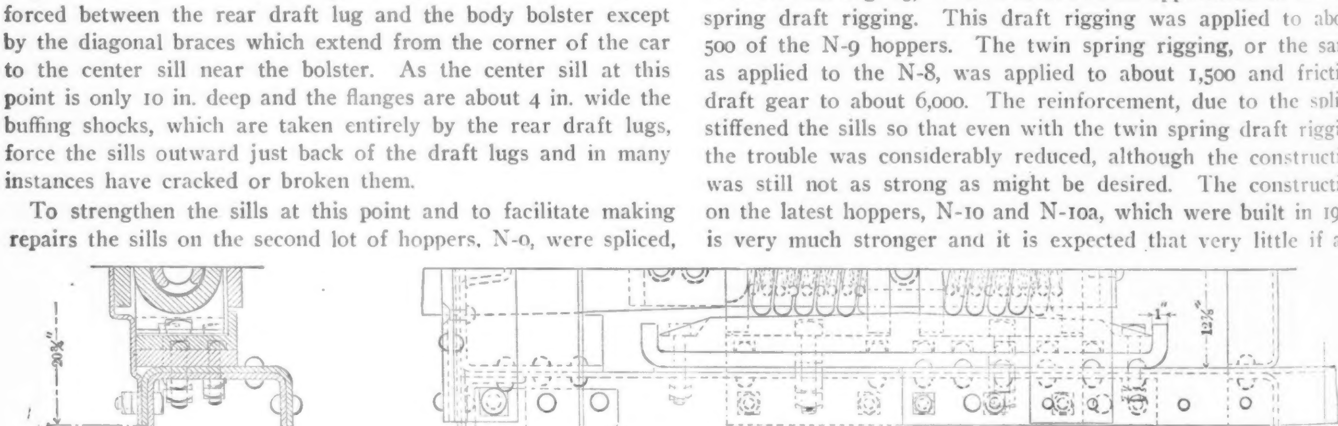

FIG. 15.—END SILL AND DRAFT SILL CONSTRUCTION OF SECOND LOT OF HOPPER CARS (N-9), SHOWING APPLICATION OF TANDEM SPRING DRAFT GEAR.

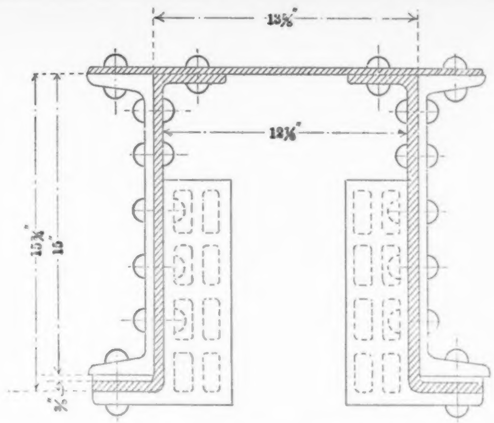

FIG. 17.—CROSS-SECTION OF EXTENSION CENTER OR DRAFT SILLS ON N-10 AND N-10A HOPPERS.

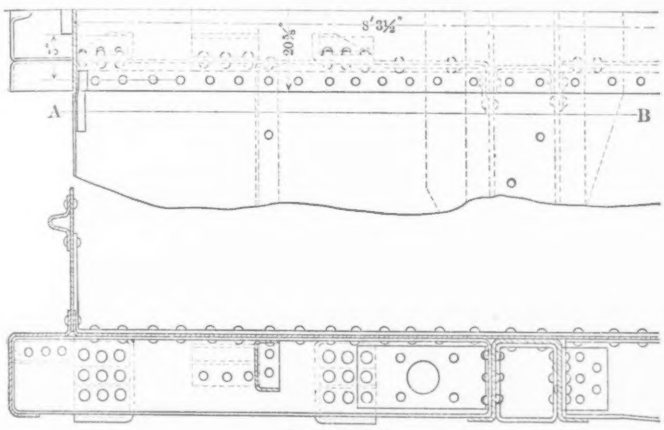

FIG. 20.—METHOD OF REINFORCING THE DRAFT SILL CONNECTION TO THE BODY BOLSTER ON CLASS O-12 AND O-14 GONDOLAS. (SEE ALSO FIG. 48.)

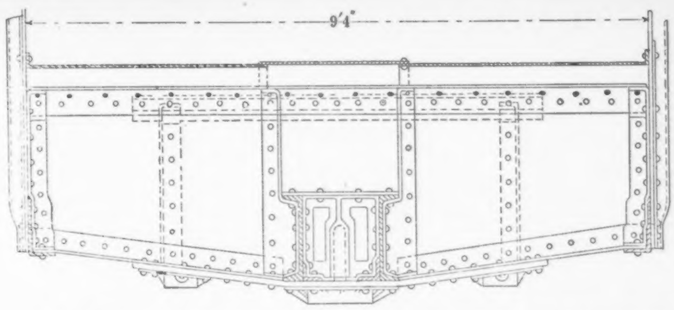

FIG. 18.—BODY BOLSTER ON LAST LOT OF HOPPERS (N-10 AND N-10A). SEE FIG. 16 FOR PLAN AND SECTION.

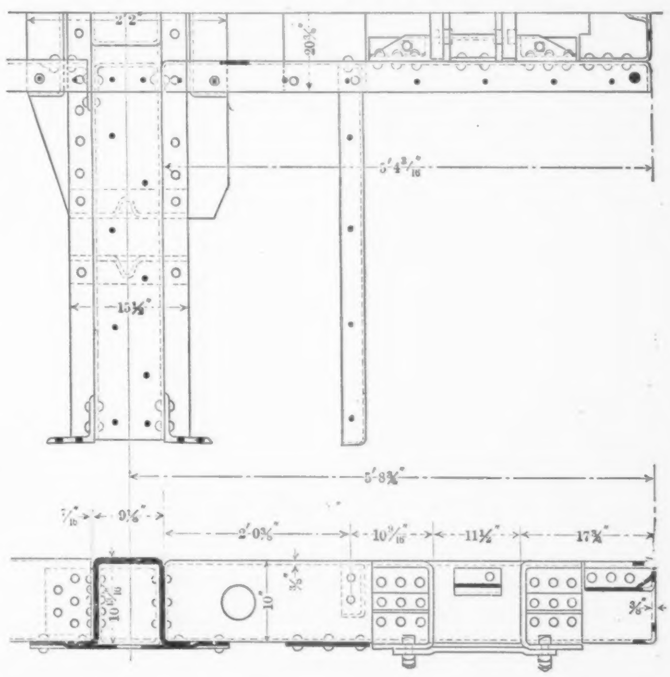

FIG. 19.—BODY BOLSTER, DRAFT SILL AND END CONSTRUCTION ON FIRST TWO CLASSES OF GONDOLA CARS (O-12 AND O-14).

trouble will be experienced with them. This construction is shown in Fig. 16. The center sills are 15 in. channels reinforced at the lower inside edges by 3½ x 3½ x ⅜ in. angles. These angles extend through the body bolster to the rear draft lug. The sills are spliced by a pressed steel shape in the form of a Z, as shown on the drawing and in Fig. 17. This is 15¾ in. deep and is riveted to the web of the center sill channels by seventeen ⅞ in. rivets, also to the lower flanges of the channels and to the top cover plate. Friction draft gear is used and the draft lugs are of cast steel.

On the first two classes of hoppers, the N-8 and the N-9, the old type of pressed steel body bolster was used. This gave fairly good satisfaction except that that part between the center sills was hardly stiff enough to properly support the center plate. The bottom cover plates on the earlier cars were very light and on some of the later orders were increased in thickness, but even this did not give good satisfaction and on the latest cars a much stronger type of body bolster was used, as shown in Fig. 18. A heavy steel casting was placed between the center sills, forming a substantial support for the center plate. The section of the bolster is such that it is much stronger vertically than the older designs. The N-8 and N-9 hopper cars were equipped with pressed steel end sills, but these were changed on the N-10 and N-10a to a rolled channel. On class N-8 the striking plate consisted of a ¾ x 2½ in. bar, the only other reinforcement being the pressed steel shape, which was riveted between the center sills directly back of the striking plate, as shown on the drawing. The construction on the N-9 was quite similar except that a pressed steel shape was placed between the striking plate and the end sill, as shown in Fig. 15. This was somewhat more satisfactory than the earlier construction, but was superseded on the last lot of cars by a heavy steel casting, as shown in Fig. 16, which has thus far been very satisfactory. The carry iron on this later type of cars is also of cast steel. A few of these have been broken. The end sill is reinforced between the center sills by a steel casting.

Gondola Cars.—A somewhat similar development has taken place in connection with the gondola cars. The first two classes, the O-12 and the O-14, were very much alike. These cars were fitted with continuous body bolsters, as shown in Fig. 19, the extension center sills or draft sills being of pressed steel 10 in. deep with flanges about 4 in. wide. These sills were riveted to the bolster by three ¾ in. rivets and in addition were reinforced by a cover plate about ¼ in. thick and to some extent by the two pressed steel diaphragms, or cross braces, extending between the center and the side sills. This construction has not proved strong enough and when the cars come in for heavy repairs the draft sills are more securely fastened to the bolster by a ½ in. angle plate, and a ½ in. cover plate is applied in place of the lighter one, extending from back of the bolster to the end sheet and up on the end sheet a distance of 13¼ in. The method of repairing and reinforcing these sills is shown in Figs. 20 and 48. The same difficulty was experienced with the bolsters on these two classes of cars as on the earlier classes of hopper cars, the central portion not being stiff enough to properly support the center plate. The striking plate on the O-12 consisted of a ¾ x 2½ in. bar and was reinforced behind the end sill the same as on the N-8 hopper cars. On the second class of gondola cars a pressed steel plate was placed between the striking plate and the end sill, as shown on Fig. 21.

On the last class of gondola cars, the O-17, Fig. 22, the center sills were made continuous and consisted of a pressed steel shape reinforced at the lower inside edge by a 3½ x 3½ x ⅜ in. angle, which extended through the bolster to the rear draft lug. Between the center sills at the body bolster a steel casting was used somewhat similar to that one on the N-10 hopper cars. The construction of the center sills between the bolster and the end sill was also similar to that used on the hopper cars, as shown in Fig. 17, in that it consisted of a heavy Z-shaped pressed steel

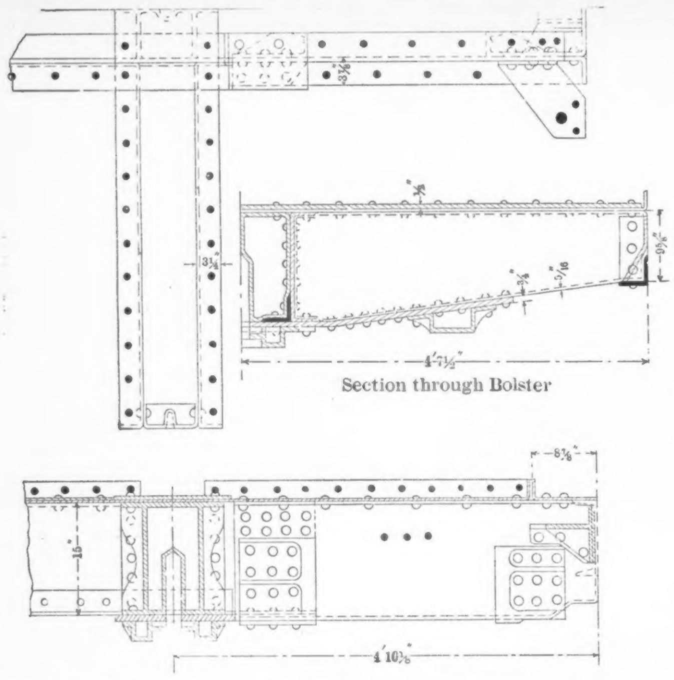

FIG. 22.—BODY BOLSTER AND DRAFT SILL CONSTRUCTION ON THE LAST LOT OF GONDOLA CARS (O-17).

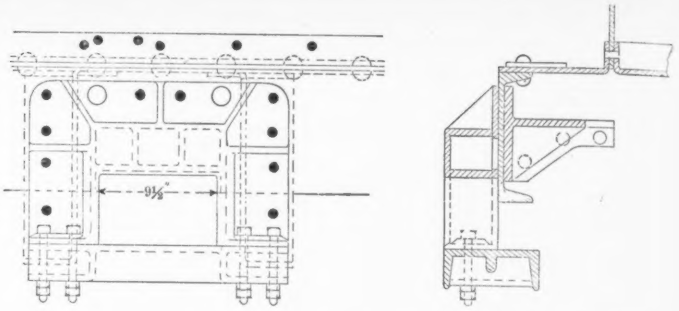

FIG. 23.—END SILL CONSTRUCTION AT STRIKING PLATE—O-17 GONDOLAS.

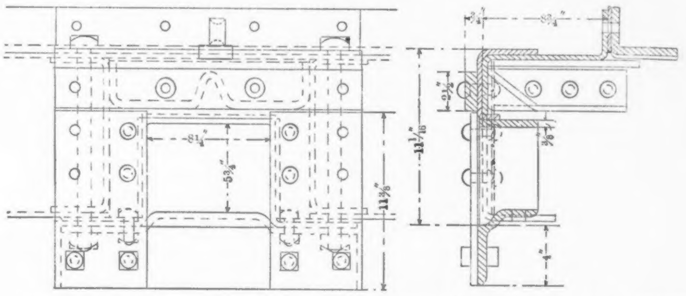

FIG. 21.—END SILL AND STRIKING PLATE CONSTRUCTION ON SECOND LOT OF GONDOLA CARS (O-14).

plate, 15¾ in. deep, which was spliced to the center sill. A steel casting similar to that used on the hopper cars, as shown in Fig. 23, was used for a coupler striking plate and a casting was also placed between the center sills, reinforcing the end sill at this point. The end sheets of the first two classes of gondola cars were stiffened by a couple of vertical angles, but these ends proved to be weak, and as the cars come in for heavy repairs the vertical braces are removed and replaced by heavy horizontal braces, the same as are used on the last lot of gondolas. One of the cars to which these braces were just being applied, in fact had not yet been riveted in place, is shown in Fig. 24. The twin spring draft rigging was used on the O-12 and friction draft gear on the O-14 and the O-17 classes, the O-17 having cast steel draft lugs.

Trucks.—On the N-8 hoppers and the O-12 gondolas the Schoen pressed steel truck was used, both the top and bottom arch bars being of pressed steel. This truck weighed about 6,960 lbs. On the first 2,000 of the N-9 hoppers the pressed steel truck having the top arch bar only of pressed steel was used. This

FIG. 27.—DAMAGED SIDE SHEETS.

truck weighed about 7,330 lbs. A similar truck was used on the first 3,000 cars of the O-14 class, which weighed 6,960 lbs. Seventeen hundred of the N-9 class were equipped with a lateral motion truck and the last 4,000 cars of that class were equipped with the diamond arch bar pressed steel truck. The last 1,000 cars of the O-14 class were equipped with a lateral motion truck. The last lot of gondolas and the last lot of hopper cars were

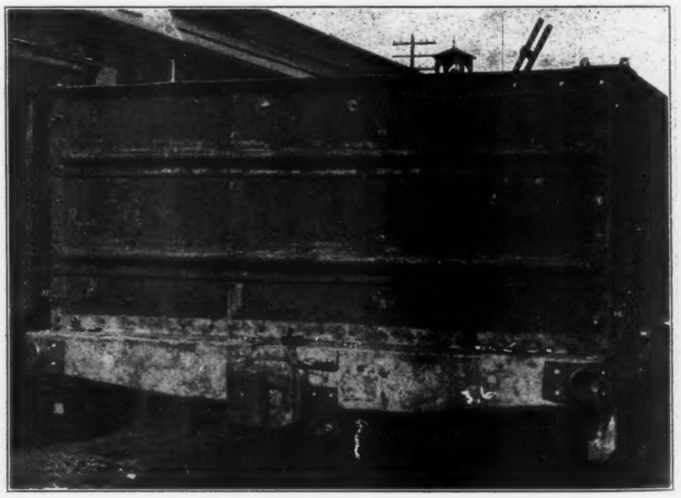

FIG. 24.—THE ENDS OF THE EARLIER GONDOLA CARS ARE BEING REINFORCED WITH HEAVY HORIZONTAL BRACES.

equipped with diamond arch bar trucks and structural type truck bolsters.

New Material Required for Repairs.

As will be seen from the section on typical repairs very little if any new material is required, no matter how bad the damage may be, except such as may be required for splicing the sills or other parts and patching the sheets. Most of the material used for patching is obtained from the locomotive boiler shop scrap pile. About the only materials used in addition to this are the rivets, the oil used in connection with the flange furnace fire and the air for the furnaces and the pneumatic tools.

The records show that in five years only one full length side or center sill has been ordered. In cases where the ends of the center sills, on the older cars, are broken off too near the bolster new pieces are required for replacing the end, but the longest of these is only 73 in. in length and can readily be made with very

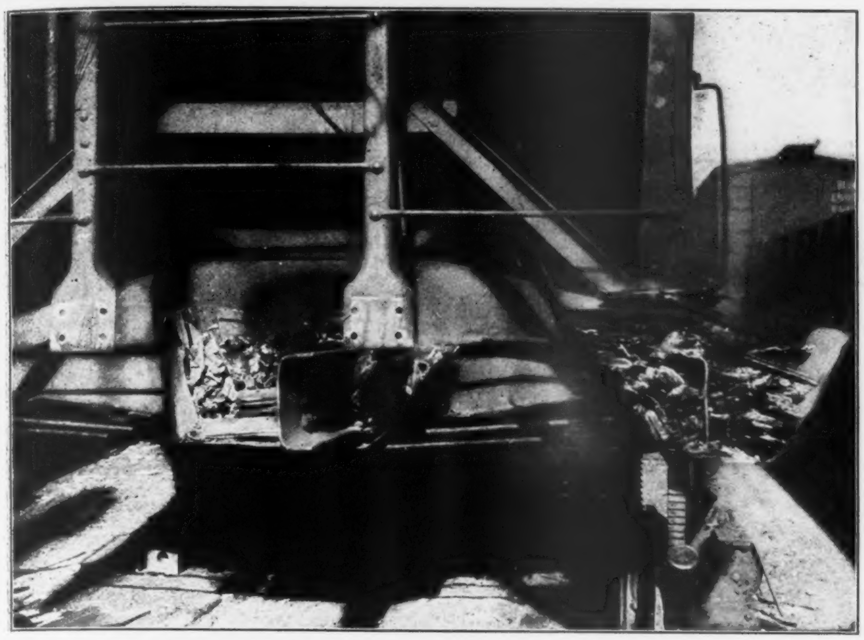

FIG. 25.—HEATING THE ENDS OF A SIDE AND TWO CENTER SILLS.

does not require his entire attention, and he assists the rest of the gang while the iron is being heated. In the freight car repair yard there is plenty of scrap wood, so that the fuel costs nothing.

Fig. 25 shows one of these hopper cars with the end of one side sill and the two center sills being heated. The center sill to the left has been broken off and the broken end will have to be straightened so that it can be spliced. When the different parts have become sufficiently heated the jack is lowered and the sheet iron, with the fire on it, is lifted to one side and the sills are straightened with hammers. To space the sills the proper distance apart a wooden templet is bolted to the top flanges at the ends after the sills have been heated and pulled into place. The sills are shown after they have been straightened in Fig. 26. The heavy iron bar at the right is used as a ram in helping to straighten the center sills.

If the side sheets are bent, but are not injured sufficiently to remove them from the car, it is the usual custom to take the

FIG. 28.—A TORN AND BENT SIDE SHEET AWAITING REPAIRS.

FIG. 26.—THE SILLS SHOWN IN FIG. 25 AFTER THEY WERE STRAIGHTENED.

simple dies. As far as can be ascertained it has never been necessary to order any of the large side sheets, for no matter how badly they have been bent or torn they can always be patched up in good shape.

Straightening Material in Place.

Damaged parts are often straightened without removing them from the car. When the center sills on the hopper cars are bulged out just behind the rear draft lug it is necessary to straighten and reinforce them. Usually, in cases of this kind, the end sill is damaged so that it has to be removed and the end of the side sills are also damaged. A piece of galvanized iron from an old car roof is placed on top of a jack, placed underneath the damaged part, and a fire is built on it underneath and around the damaged member. The fire underneath the center sills in the accompanying illustration is carried on the two rods whose ends are supported on the side sills. One of the men in the gang is detailed to build the fire and attend to it, but this

box jack, shown in Fig. 12, and support the wooden end of it on blocking near the juncture of the hopper and side sheets and have the other end screwed tight against a block near the distorted part of the sheet. The sheet can then easily be hammered into shape.

Some Typical Repairs.

As may be seen from the following illustrations and description of typical repairs which are being made at the Mt. Clare shops, the work is simple, very little special equipment is required and very little new material is used. No matter how badly a sheet is damaged it can usually be straightened and repaired at a comparatively small cost. Badly bent and torn side sheets are shown in Figs. 27 and 28, waiting to be straightened at the flange shop. The method of straightening sheets of this kind on the face plate with wooden mauls is shown in Fig. 29. After the sheet has been approximately straightened the smaller kinks are removed with iron hammers. When the sheets are torn a patch of 1/4 in. material, cut to approximately the shape of the tear, is placed on the outside of the car and riveted with 5/8 in. rivets spaced about 4 in. apart. The side and center sills are straightened at a large open fire in the boiler shop. A number of damaged sills waiting to be straightened are shown in Fig.

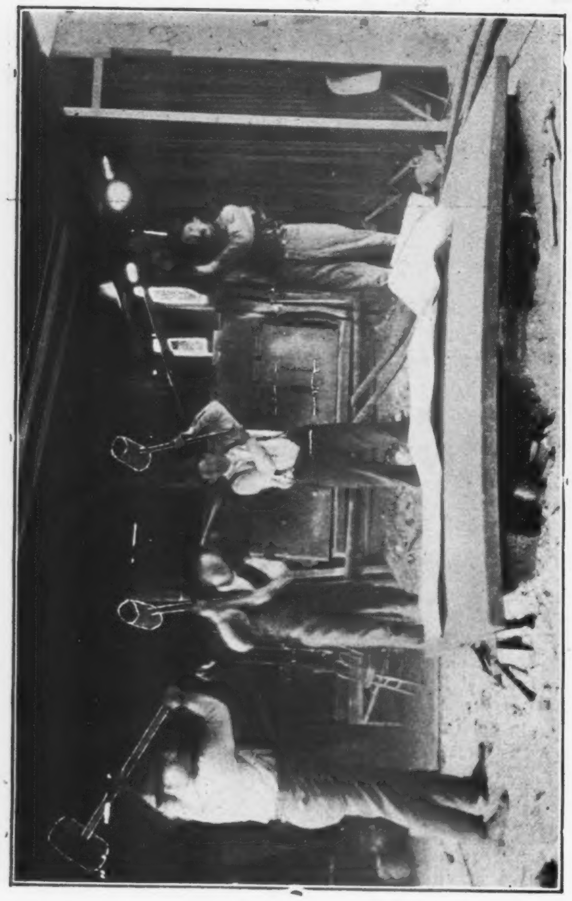

FIG. 29.—STRAIGHTENING A BENT SHEET IN THE FLANGE SHOP.

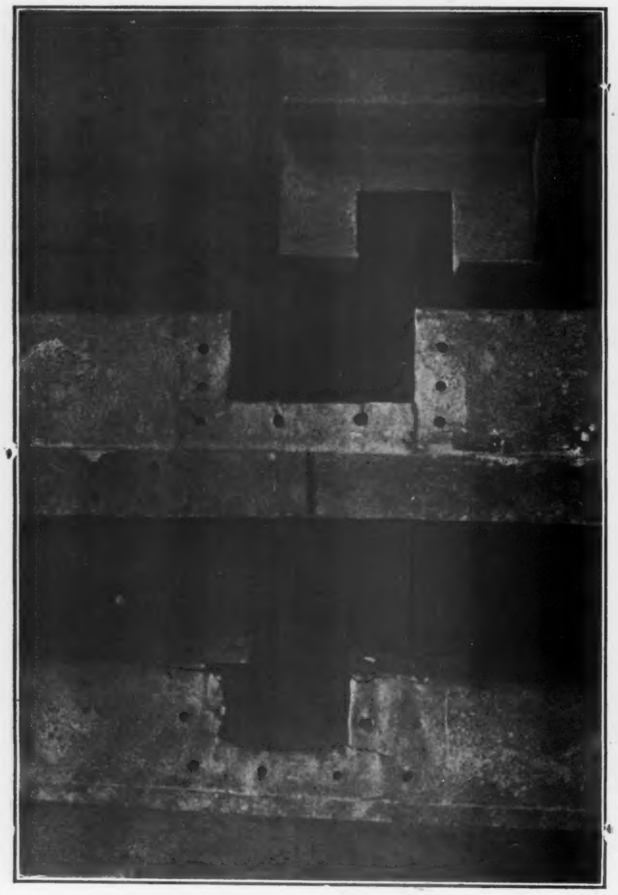

FIG. 33.—DAMAGED END SILLS AFTER BEING STRAIGHTENED; ALSO THE REINFORCING PIECE FOR THE CENTER.

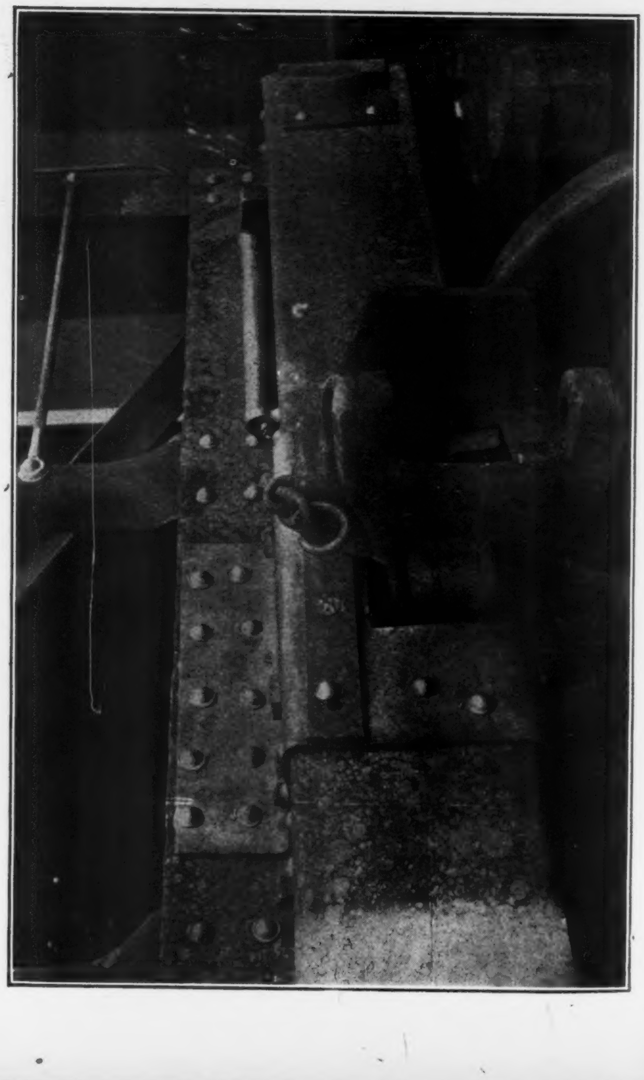

FIG. 34.—DAMAGED END SILL REPAIRED AND IN PLACE ON THE CAR.

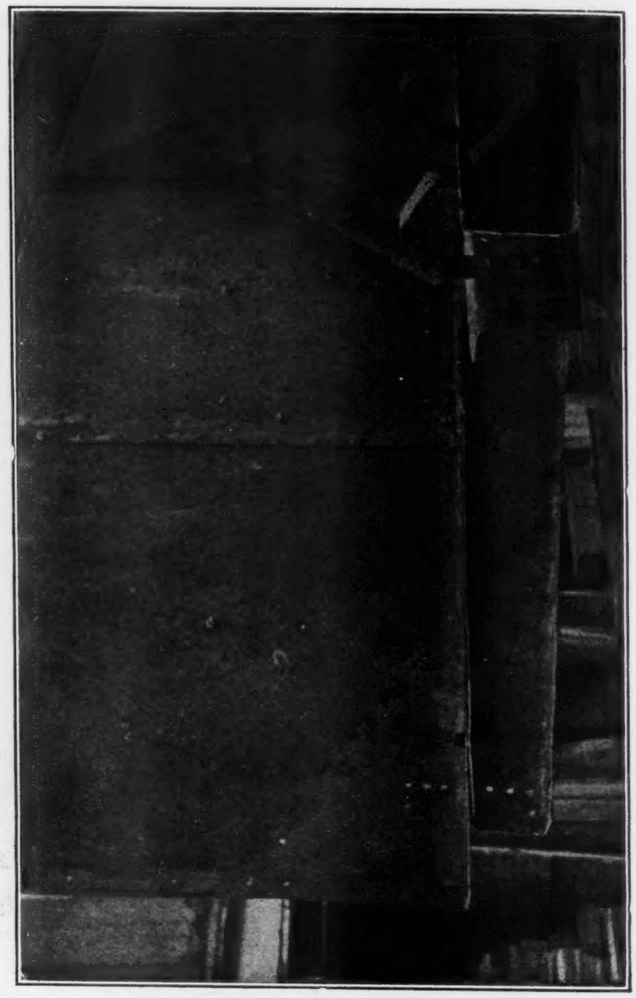

FIG. 36.—CENTER SILLS ON A HOPPER CAR BROKEN BACK OF THE BODY BOLSTER AND A SIDE SILL BROKEN AT THE BOLSTER.

FIG. 30.—DAMAGED SIDE AND CENTER SILLS.

FIG. 31.—BADLY DAMAGED END SILL AND SHEETS.

FIG. 32.—BENT AND TORN END SILL.

30. These sills can easily be straightened and if they are cracked or broken can readily be spliced.

Hopper Cars.—Probably the greatest trouble that is experienced with the older hopper cars is the crushing of the end sills. An end sill that has been badly damaged is shown in Fig. 31, and one which has been torn and was just about to be taken into the flange shop for straightening is shown in Fig. 32. These sills are placed in the furnace and heated and then hammered approximately into shape on the face plate, straightened in the screw press and finally shaped accurately on a former provided for that purpose and shown just in front of the men in Fig. 13. A couple of these end sills that have just been straightened are shown in Fig. 33. When the sills are cracked or torn, as shown in the illustration, the reinforcing piece at the right is placed over them at the center. This piece is quite similar to that used on the N-9 hoppers except that the top flange extends upward and is riveted to the end sill by the ten additional rivets, as shown in Fig. 34, which shows one of these repaired end sills in place on the car. The cost of removing, straightening and replacing one of these sills is not very great, as may be seen by referring to the section on the comparative cost of repairing steel and wooden cars.

The center sills on the N-8 hoppers are often broken back of the draft lugs and in some instances have been broken back of the bolster. If the sills are broken back of the rear draft lugs and at least 8¾ in. from the bolster, as shown in Fig. 35, the old piece is spliced to the sill, as shown. If the break is back of the bolster and at least 8¾ in. from the bolster, as shown on the diagram, the old piece is spliced on. If the sills are broken between the draft lugs it is necessary to cut the sill 8¾ in. in front of the bolster and splice on a new piece, or if the sills are broken on either side of the bolster and less than 8¾ in. from it a new piece either 43 in. or 73 in. long, depending on which side of the bolster the break is, is spliced to it.

A car that was badly damaged and had both of the center sills broken back of the bolster and both of the side sills broken at the bolster is shown in Fig. 36. A ⅜ in. plate 22½ in. long is riveted on the inside of the center sill and a ⅜ in. piece of the same length, of channel shape, formed to fit snugly inside of

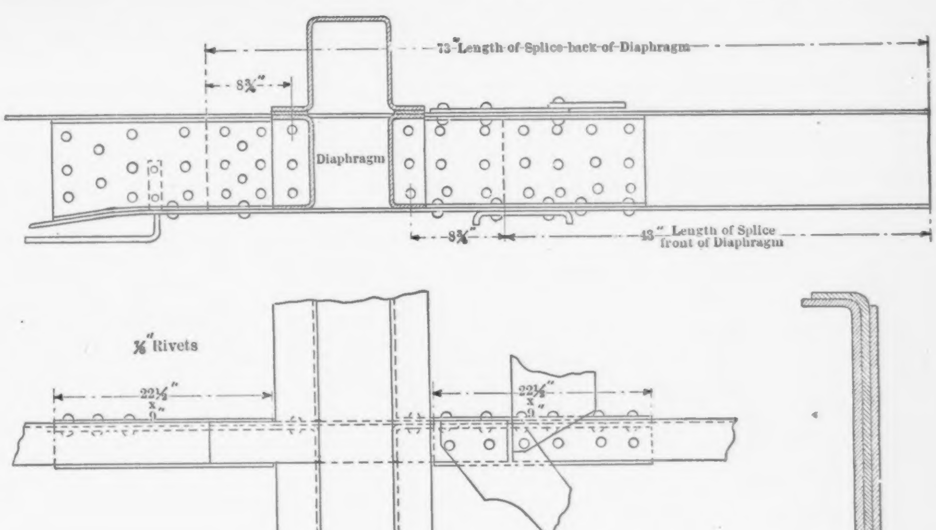

FIG. 35.—METHOD OF SPLICING CENTER SILLS BOTH IN FRONT AND BACK OF THE BOLSTER ON CLASS N-8 HOPPERS.

FIG. 41.—SIDE SILL OF HOPPER BROKEN NEAR THE CENTER OF THE CAR.

FIG. 42.—DRILLING HOLES FOR THE SIDE SILL SPLICE WITH A PNEUMATIC DRILL.

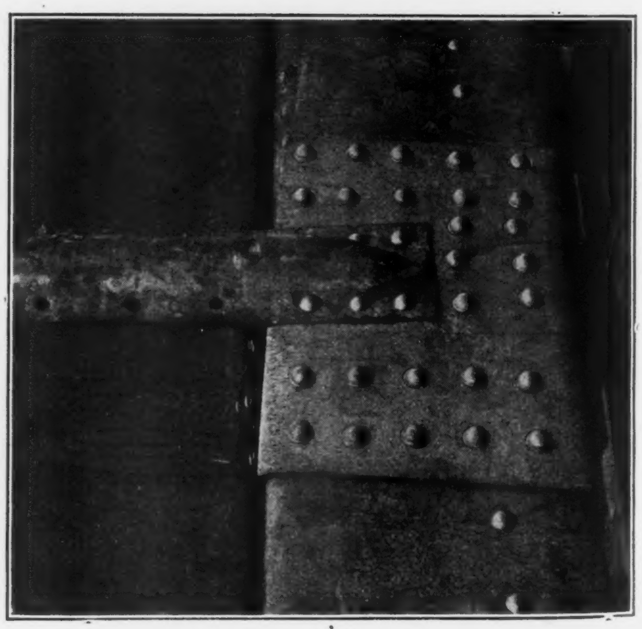

FIG. 43.—FINISHED SPLICE ON SIDE SILL.

FIG. 44.—TORN BODY BOLSTER DIAPHRAGM.

FIG. 45.—PATCH ON BODY BOLSTER DIAPHRAGM.

FIG. 37.—TWO BROKEN CENTER SILLS SPLICED BACK OF THE BOLSTER. (SEE FIG. 36.)

FIG. 39.—HOPPER CAR SIDE SILL BROKEN AT THE BOLSTER.

the center sill, is riveted to the outside. The flanges of the reinforcing channel are fastened to the sill by two rivets on either side of the break at both the top and bottom. A photograph of one of these splices is shown in Fig. 37. The work had not been quite finished when the picture was taken and the holes for the rivets in the top and bottom flanges had not yet been drilled.

The method of splicing the center sills between the bolster and the end sill is quite similar. A photograph of one of these splices is shown in Fig. 38. In this case the holes had been drilled through the flanges for the rivets, but they had not yet been driven. Both of the center sills were broken. The break was directly back of the rear draft lug and the reinforcing plate was made long enough to extend to the front end of the lug.

Side sills broken at the body bolster are shown in Figs. 36 and 39. The latter photograph gives a good idea of the bolster construction on the older hoppers. The method of making the splice is a simple one and is shown in Fig. 40. These cars have a 3/8 in. plate, used to stiffen the side of the car at the bolster for jacking purposes, but which does not have the flange extending underneath the sill. When the sills are broken at this point the old plate is scrapped and a new one, similar to the one shown in the illustration, is used. The only additional rivets required are the two at the lower flange and the four indicated by arrow heads in the illustration.

Occasionally the side sills may be broken between the two bolsters. A broken sill of this kind which had been badly buckled and is shown after it had been straightened and while the car was being re-assembled is illustrated in Fig. 41. A 3/8 in. plate was placed on the inside of the sill and a 3/8 in. plate, flanged at the lower end, and extending under the sill, was placed on the outside. Fig. 42 shows the method of drilling the holes in the sill for these splice plates. An "old man" or brace was fastened in place and the holes were drilled with a pneumatic drill. A view of the finished splice is shown in Fig. 43.

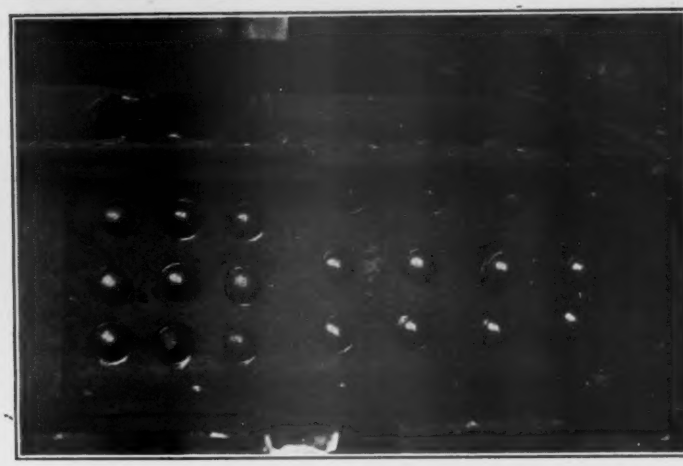

FIG. 38.—CENTER SILLS ON HOPPER CAR SPLICED IN FRONT OF THE BOLSTER AND AT THE REAR DRAFT LUG.

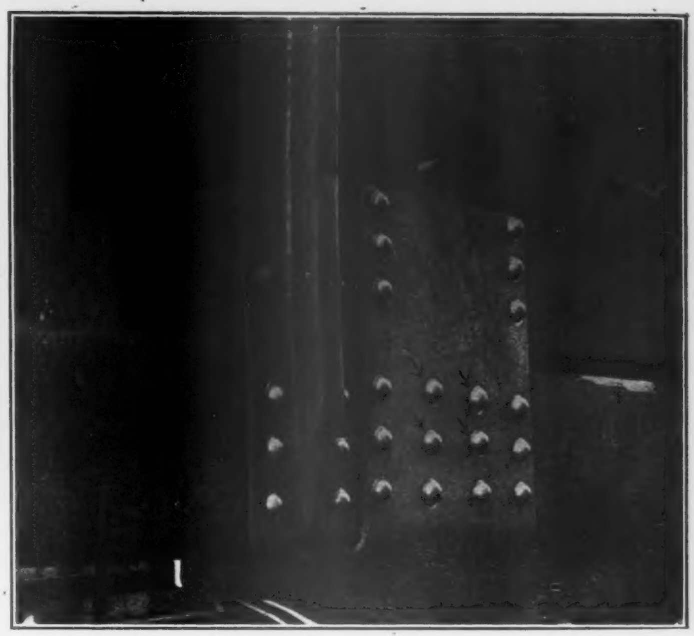

FIG. 40.—BROKEN SIDE SILL, SHOWN IN FIG. 39, SPLICED.

A body bolster diaphragm that had been torn is shown in Fig. 44. This was repaired by riveting on a plate 3/8 in. thick and 10 in. wide, Fig. 45.

Gondola Cars.—The method of stiffening the end sheets on the O-12 and O-14 gondolas has already been mentioned (page 166). The greatest difficulty encountered with these cars is the tearing away of the extension center sills, or draft sills, from the body bolsters. These draft sills are attached to the bolster by three rivets at the vertical portion and one rivet through the lower flange of the bolster. In addition they are held to the bolster cover plate by one rivet. The way in which the sills are torn from the bolster is illustrated in Figs. 46 and 47. As has been stated (page 165), in repairing damages of this kind the top cover plate on these cars is removed and replaced with a 1/2 in. plate which extends from the hopper opening to the end of the car and up on the end 13 1/4 in. to take the rivets in the bottom edge of the lower of the two cross braces, which are being applied to these cars as they come in for heavy repairs. The old cover plate was only 1/4 in. thick and the rivets were spaced about 9 in. apart. The new 1/2 in. plate has rivets spaced about 4 1/2 in. apart. The fastening of the sills to the bolster is reinforced, as shown in Figs. 20 and 48. The sill is bolted to the bolster, because it is impossible to drive rivets.

Very few of the last lot of gondola cars are to be found on the repair track. The writer was able to find only one, during his visit to Mt. Clare, and this had the lower flange of one of the center sills and the cross braces between the center sill and the side sill more or less damaged, although the rest of the car was uninjured. A view looking along the lower edge

FIG. 47.—ANOTHER EXAMPLE OF DRAFT SILLS TORN FROM BODY BOLSTER ON GONDOLA CAR.

FIG. 48.—DRAFT SILL ON GONDOLA CAR REPAIRED AND REINFORCED. (SEE ALSO FIG. 20.)

FIG. 46.—DRAFT SILLS TORN FROM THE BODY BOLSTER ON O-12 GONDOLA CAR.

of this damaged center sill is shown in Fig. 49. The sill was removed and straightened. To do this it was necessary to remove the floor plates and loosen the sill from the cross braces and bolsters and drop it out, the sides of the car remaining intact.

Occasionally a car is damaged and the underframe is sprung out of shape so that two of the diagonally opposite corners are higher than the other two. In cases of this kind the high corners are connected to the rail by a ratchet pulling jack and are pulled down until, when released, the four corners are on a level.

Cost of Repairing Steel and Wood Cars.

The following figures are presented to briefly convey some idea as to the comparative cost of repairing steel and wooden cars.

Removing and replacing a damaged end sill on a steel car:

Labor	$3.97
Material	.52
Total	$4.49

Removing and renewing a damaged end sill on a wooden car:

Labor	$0.95
Material	3.78
Total	$4.73

*   *   *   *   *   *   *

Removing an end sill and repairing the draft on a steel car:

Labor	$10.33
Material	1.08
Total	$11.41

This figure assumes that the center sills were bulged out and would have to be heated and bent back into place.

Cost of repairing center sills between the body bolster and end sill on a steel car:

Labor	$18.62
Material	3.53
Total	$22.15

These figures are based on the assumption that

both of the center sills were broken and required splicing and that the end sill was taken off and straightened.

Cost of repairing the center sills, including a defective end sill, and the draft gear on a wooden car:

Labor	$10.22
Material	19.86
Total	$30.08

This figure is based on the assumption that new center sills and end sills would have to be furnished on the wooden car. In cases of this kind, adjacent parts are usually damaged, but this has not been taken into consideration in making up these figures.

* * * * * * *

Repairing side sill bent near the end sill on a steel car:

Labor	$1.17
Material	0.05
Total	$1.22

Splicing a side sill near the end sill on a wooden car:

Labor	$1.28
Material	0.78
Total	$2.06

Ordinarily a steel car in this condition would not have to go in for repairs until some other part was injured, but the side sill on a wooden car would probably be splintered and other parts damaged.

FIG. 49.—LOWER EDGE OF CENTER SILL DAMAGED ON CLASS O-17 GONDOLA CAR.

* * * * * * *

Splicing a side sill at the bolster on a steel car:

Labor	$3.53
Material	0.63
Total	$4.16

Splicing a side sill at the bolster on a wooden car:

Labor	$2.87
Material	3.02
Total	$5.89

* * * * * * *

Cost of repairing or splicing a side sill on a steel car, both ends:

Labor	$7.06
Material	1.26
Total	$8.32

Cost of removing and renewing side sill on wooden car. This would be necessary if both ends were damaged as on the steel car above:

Labor	$5.25
Material	6.52
Total	$11.77

* * * * * * *

The following figures are for repairing one of the worst damaged hopper cars. It was one of class N-9. The sills were spliced in eight places and the sheets were patched in eleven places. The car had to be practically cut to pieces, the various parts straightened up, repaired and re-assembled.

Cost of repairing the body was:

Labor	$190.00
Material	38.83
Total	$228.83

Trucks:

Labor	$2.70
Material	16.40
Total	$19.10

The labor cost for repairing badly damaged steel cars usually runs from about $160 to $175 per car.

* * * * * * *

A study of the above figures will give an idea of the relatively small amount of new material which is required for repairing steel cars as compared to wooden cars.

Painting.

The present practice on the Baltimore & Ohio is to, as far as possible, repaint the steel cars at regular intervals, but the equipment is so large and the demand for cars has been so heavy during the past three or four years that many of them have been in service for seven or eight years without repainting. It is even a question as to whether the increased life due to repainting will be great enough to offset the cost of keeping the car out of service, under present conditions, long enough to repaint it. There is also a question as to just how often a steel car should be repainted in order to give the best result from the standpoints of increased life and service requirements. The damage to the outside of the car due to corrosion is very slight, the greater difficulty being with the inside. An ordinary paint placed on the inside will be entirely obliterated in six months or less, and certainly it would hardly be advisable to take the car out of service every six months to paint the inside of it. A special paint is needed for this purpose, although the conditions to be met are so severe that it is doubtful whether it will be possible to get a covering that can withstand them for any great length of time. The underframe is not exposed to moisture and it is questionable if it will pay to repaint it at all after it has come from the builder. As these cars can be painted only during the months from May to November, it is rather a difficult problem to take care of a large equipment and keep it in first-class condition as far as appearance is concerned.

Practically the only painting that really accomplishes any very great results, as regards preserving the metal, therefore, is that which is applied when the cars are first built. As is well known the metal aprons on coaling trestles which are out of use corrode very rapidly, while those installed at the same time, but which are in constant use, last until the metal is actually worn out by friction. The same thing will, of course, apply to steel cars, and it would seem that the best results could be obtained by keeping the cars constantly in service. It would also appear that for this reason the flat bottom cars would be in greater need of a protective coating on the interior since the friction due to loading and unloading is much less than on the hopper cars.

The following extracts from the Baltimore & Ohio specifications for painting the new all-steel cars are of interest:

Before painting metal parts, all rust and scale must be thoroughly removed by the use of scrapers and wire brushes, or sand blast, and all oil and grease thoroughly removed by the use of benzine so that all parts to be painted have a thoroughly clean metal surface. The first coat is to be applied immediately, before additional rust or dirt forms on the surface. All parts where metal is placed on metal and either riveted or bolted must be plastered with pure red lead mixed in raw linseed oil to the consistency of putty before assembling and after assembling all crevices must be thoroughly filled with the same mixture.

The painting is to be done with a hand brush not over 6 in. wide and not more than one coat is to be applied in each twenty-four hours. The body and underframing are to be given three coats, the first one of black, the second one of Baltimore & Ohio freight car paint, which is red, and the third one of black.

Three coats, two black and one red, are used for two purposes. In the first place the combination of the black coat, the coloring being of lamp black, which is fine, and a red paint, which contains iron oxide, which is very coarse, seems to give much

better results than where all the coats are of black or all of the red paint. The different colored coatings also make it possible to check the number of coats with greater accuracy.

For repainting steel cars only one or two coats of paint are used. The cars are cleaned with wire brushes and scrapers, and if heavy repairs have been made a coat of red freight car paint is first applied and then a coat of black. If light repairs are made, or if the cars require repainting only for the purpose of maintaining the appearance and preserving the identity, only the one coat of black paint is applied. This class of painting is frequently done when cars are held under load in transportation yards and on coaling trestles, so that the car is not held out of service unnecessarily.

The specifications for the first coat of paint are as follows:

10 gal.	semi-paste paint	68.8	per cent.
5 "	raw linseed oil	16.1	" "
5 "	japan oil	15.1	" "

(Pigment in mixture—48 per cent.)

The specification for the semi-paste paint is as follows:

Freight car paint must be furnished in the semi-paste form, containing about 70 per cent. of pigment, and between 28 and 32 per cent. of pure raw linseed oil, with no admixture of rosin oil, petroleum products, or adulterants of any kind.

The pigment must be at least 35 per cent. pure oxide of iron, and contain not less than 2 nor more than 5 per cent. calcium carbonate. It must contain only such inert matter as occurs with it in nature, with no addition of barytes, aniline colors, lakes or any other organic coloring matter, no caustic substances or other ingredients, except calcium sulphate fully hydrated and silica.

The pigment must be so finely ground that when thinned with pure raw linseed oil, as shown in the following test, the opaque mass must not have settled down more than 1¾ in. in three hours, with no separation of coarser particles at the bottom. Take a ⅝ in. test tube and fill with pure raw linseed oil to a height of 4½ in., then add the semi-paste until the height of the oil is 5 in. from the bottom, cork, shake well, and stand in an inverted vertical position for three hours, the temperature being 70 degs. F.

The specifications for the coat of black are as follows:

1 lb. Germantown lamp black, dry.
2 lb. semi-paste paint, as above.
⅝ gal. raw linseed oil.
⅝ gal. japan oil.

This paint to be mixed and allowed to soak at least twenty-four hours before it is used.

LOCOMOTIVE PISTON VALVES.

By Hal. R. Stafford.*

The locomotive is indebted to the marine branch of steam engineers for more than one great improvement. Next in importance to the principle of compounding, in the opinion of many, is the use of the piston valve, or "piston slide valve" as we have been taught to say. In this description the former term will be used.

The Piston Valve in Marine Practice.—Although its advantages of simplicity and perfect balance were early recognized, its adaption in marine practice does not seem to have come about through the recognition of any inherent merit, but in the words of an ex-marine engine designer, it was only used "as a subterfuge for a slide valve, when such a valve would be so large as to be unwieldy and difficult to balance."

Historical.—While this article is not intended to be historical, a brief account of the earlier applications of the piston valve to the locomotive would seem essential. Probably its first application to locomotive work was made by Mr. T. B. Henney, then superintendent of motive power of the New York & New England Railroad, who tried some experiments with piston valves (see American Engineer and Railroad Journal, October, 1904, p. 384) as applied to simple engines, but without any marked success, because of the use of too small a valve. About this time also the Vauclain compound locomotive having a piston valve appeared. As it performed the function of distributing steam to two cylinders, the reason for its application in this case is obvious, since the use of a slide valve would have been almost a mechanical impossibility.

For its earliest successful application to simple engines, we are mainly indebted to Mr. John Player, and the Brooks Locomotive Works, of which he was then mechanical engineer, although mention must be made of its application to a single engine on the Norfolk and Western soon after this, by Mr. G. R. Henderson. Most of the early investigation and exploitation of the piston valve engine, however, was the work of the Brooks Works, which for a long time was almost alone in the field.

The application of piston valves by this company dates from 1889, although these first engines were really slide valve engines, with a cage containing the valve fitted into a peculiarly shaped steam chest. This arrangement shows much ingenuity, since the whole cage and valve were arranged to lift inside the chest, to give relief in the same manner as the slide valve. It was not until several years later that the Brooks Works commenced building bona-fide piston valve engines, which became increasingly popular.

Those concerns interested in cross-compounds soon adapted the piston valve for the high-pressure cylinder, because of the difficulty experienced in balancing the large slide valve necessary against the high pressure used. These valves were of the outside admission type, because the low-pressure slide valve was necessarily so, and it was desirable to maintain the valve gears the same for both sides. Until the direct motion was introduced, many simple engines were built with outside admission, which were more or less unsuccessful.

Packing.—With the exception of the piston valves built at the Brooks Works, all early valves on simple or two-cylinder compound locomotives were of solid one-piece construction, with

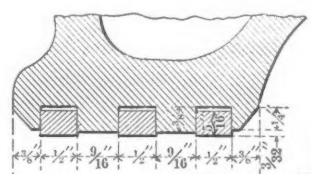

Fig.1

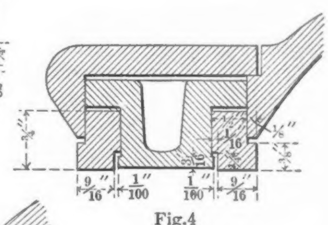

Fig.4

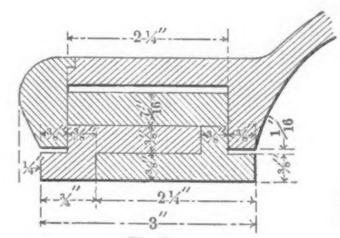

Fig.2

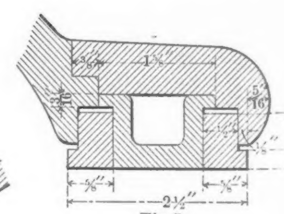

Fig.5

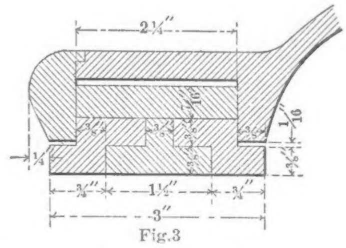

Fig.3

closed ends—that is, there was no communication between the opposite ends through the valve body—while for packing the ordinary piston snap ring of rectangular section sufficed (Fig. 1). This ring did not give a sharp admission or cut-off, which was early recognized by the Brooks people, since their first packing was of the form shown in Fig. 2, giving a ring projection over the end of the valve.

The next modification was Fig. 3. This form of packing ring proved very successful with the low steam pressures then in use, being practically steam tight and probably much better in this respect than many modern types; but as pressures increased above 180 pounds, friction became excessive, since the whole

* American Locomotive Company, Schenectady, N. Y.

face of the valve was composed of expansive packing rings set out by steam pressure. It was superseded by the L-shaped ring, Fig. 5, which offers much less surface for the pressure to act upon, the T-ring composing the middle of the face being a solid non-expansive ring. This ring is practically standard throughout the country to-day.

When the L-shaped ring first came into use, it was feared that it would break because of its light section and cause damage by the pieces falling into the ports. To prevent this the form of ring shown in Fig. 4 was designed and is still used to a great extent. But strange to say, although breakage of valve packing rings is of too common occurrence, nothing more serious happens than is caused by the loss of the ring itself. Cases have been known of valves removed which were entirely innocent of packing rings, no portion of the ring being found in the cylinder or valve chest, and no other damage being done.

Early locomotive piston valve bodies, except those built at the Brooks Works, were made in one piece, the rings being "snapped" into place as in the ordinary solid head piston. But it has been found that, no matter how carefully these rings are turned to the bore of the bushing, this practice stretches them and causes a poor fit. This is the principal reason for the adoption of the built up valve (Fig. 6) which enables the rings to be slipped into place without distortion, and allows a deeper and heavier section to be used than would otherwise be possible. It will be noted that the Brooks Locomotive Works used this built up valve from the beginning (Fig. 2).

The best fitting packing rings are turned to the old piston ring rule—the rings are turned from 1/16" to 3/32" larger than the bore, according to the size of the valve, then from ⅛" to 3/16" cut out, the ring clamped together in a jig, and turned to nominal size. This gives a ring which will bear all around the bushing and wear equally.

Advantages and Disadvantages of Piston Valves.—We have thus brought the piston valve down to present day usage, which is well represented by Fig. 6. Some of its advantages are perfect balance, that is, when properly constructed, with just enough area of ring acted upon by pressure to make it properly steam tight, without unnecessary friction; a simpler, lighter, and cheaper cylinder casting; a wearing face separate from the cylinder casting which can be cheaply renewed; ports in cylinders readily made very straight and direct; and its adaptability to any design of valve gear, since it can be placed above the cylinder, between the frame rails, or in any other position with equal facility. Its general tightness to steam is conceded by engineers on both sides of the water to be about equal to a good slide valve.* Again, it practically does away with one set of metallic packing, as almost any form of hemp packing is sufficient to hold exhaust pressure, assuming the valve to be of the inside admission type.

On the other hand, it is accused of many shortcomings, most of which can be overcome, and some of which have already been eliminated in special designs in use to-day.

Many motive power men are of the opinion that an engine equipped with piston valves cannot develop the speed of a slide valve engine, both being otherwise of the same design. The fact that some of our very fastest trains are pulled by piston valve engines would seem to refute this argument; but as many of the older engines had valves entirely too small, these opinions may have been based on such poorly designed engines. Such an opinion might have been formed by comparison with outside admission piston valve engines. This is also unfair, as the outside admission piston valve has a proverbially poor exhaust. Inside admission has become the rule, and special care is at present taken to shape the steam chest covers to direct, and to offer the least possible resistance to the exhaust.*

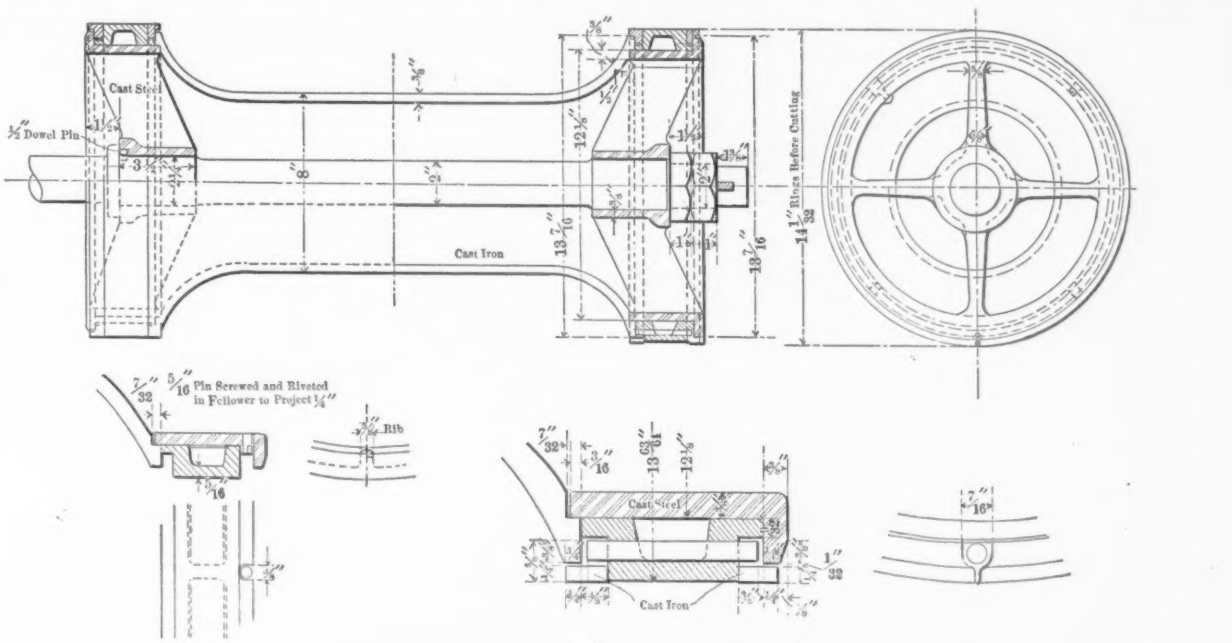

FIG. 6.

As regards the size of piston valve required, we have many opinions; but it is an established fact that the circumference of the valve, less the space occupied by the bridges, must considerably exceed the length of the slide valve port for a similar bore of cylinder. This is accounted for by the resistance offered by the bridges, and by the fact that the portion of port diametrically opposite the cylinder cannot be so effective as that nearest it. The port should be so proportioned that the area around the outside of the bushing at any point is equal to the combined area of all the openings above this point.

The following table gives recommended diameters of valves for different bores, it being assumed that the sizes given are large enough for the longest stroke commonly used with this bore. The table also shows the net length of the port (with bridges deducted) for each diameter, and the corresponding length of slide valve port in common use.

DIA. OF CYLINDER	DIA. OF PISTON VALVE	NET LENGTH OF PISTON VALVE PORT	LENGTH O SLI E VALVE PORT
17	10	25	16
18	11	26½	16
19	11	26½	18
20	12	30¼	18
21	12	30¼	18
22	12	30¼	20
23	14	34	20

Another objection to the piston valve is the fancied increase of cylinder clearance. This, while it may be that clearance is

* AMERICAN ENGINEER AND RAILROAD JOURNAL, Sept., 1905, p. 318, Master Mechanics' Ass'n Proceedings, 1906.

* See description of L. S. & M. S. consolidation locomotive AMERICAN ENGINEER AND RAILROAD JOURNAL, Dec., 1903, p. 439.

larger in many cases than on a similar slide valve cylinder, is by no means necessary. It can usually be kept between 6 and 8 per cent., except on very short stroke engines, and this is low enough with ordinary valve gear, since the 2½ per cent. of the Allfree-Hubbell system is only made possible by the use of additional exhaust valves to relieve compression. The Allfree-Hubbell valve itself is really an inside admission piston valve, of rectangular shape.

In starting a train, with the gear in long cut off, inside admission valves have a tendency to jump at the moment exhaust takes place. This is very noticeable when there is excessive lost motion in the valve gear. It is caused by the action of the exhaust on the end of the valve, and is worse with a valve follower having a considerable overhang, with a long bevel as in Fig. 4 than for one like Fig. 6. Valves with a large diameter of body, forming a free communication between the opposite ends, to equalize the exhaust pressure and allow part of it to pass to the other exhaust port, rarely exhibit this fault.

The L-ring of the proportions generally used (Fig. 6) is open to another objection—the collapse of the exhaust ring just prior to release, due to the fact that in this position the lip of the ring has only exhaust pressure under it, while it has the pressure in the port on its face. This lip is usually ¼" wide, as on Fig. 6, and it has been found that with this proportion of ring, collapse takes place when the exhaust ring laps the port about ⅛". This suggests the remedy—reduce the lip to ⅛", thickening the body of the ring by that amount. Fig. 5, the standard valve of the Chicago, Burlington & Quincy Railroad, shows such a form (the Clark ring). However, the importance of this evil (the collapse of the exhaust ring) has been somewhat exaggerated. It cannot be detected on the indicator card, since the point of exhaust opening itself is rarely distinct except at very slow speeds, and the only effect is to round off this corner a little more. It cannot be detected in the sound of the exhaust even with valves having a long lipped ring. Its only effect on steam distribution is to cause a slightly earlier prerelease. The worst feature is in the increased wear on this ring and its joint faces, caused by this movement.

The greatest disadvantage under which the piston valve labors is its inability to relieve excess pressure in the cylinder port by lifting, after the manner of the slide valve. This renders some sort of cylinder head relief valve imperative. For this purpose the ordinary spring pop valve is generally used, and although many objections are raised to this device, it has not been proved that pop valves of ample size, properly designed and taken care of, will not eliminate cylinder head breakage, except in cases of deliberate attempt to use cylinders and pistons as hydraulic rams. Various types of by pass valves are also used with success, in which the pressure in the chest is made to serve in place of the spring, in a manner analogous to the slide valve. The Vogt by pass valve is typical of this class.* This valve is open to the criticism of considerably increasing the cylinder clearance, if the passages are made large enough to be effective.

Bushings.—Piston valve bushings ordinarily have from 7 to 9 bridges, one at the bottom being wider than the others, because of the joint in the packing rings at this point. These bridges, as has been said, obstruct the flow of steam to and from the cylinder by dividing it into small streams, the sharp edges of the ports having more or less of a retarding effect. Authorities differ greatly as to the importance of this evil, but all admit that the fewer bridges the better. If we could do away with packing rings, we could do away with bridges; this brings us to the consideration of the plug valve, which has been used on the Continent in locomotive work, and in an adjustable form by the Brooks Locomotive Works some years ago.

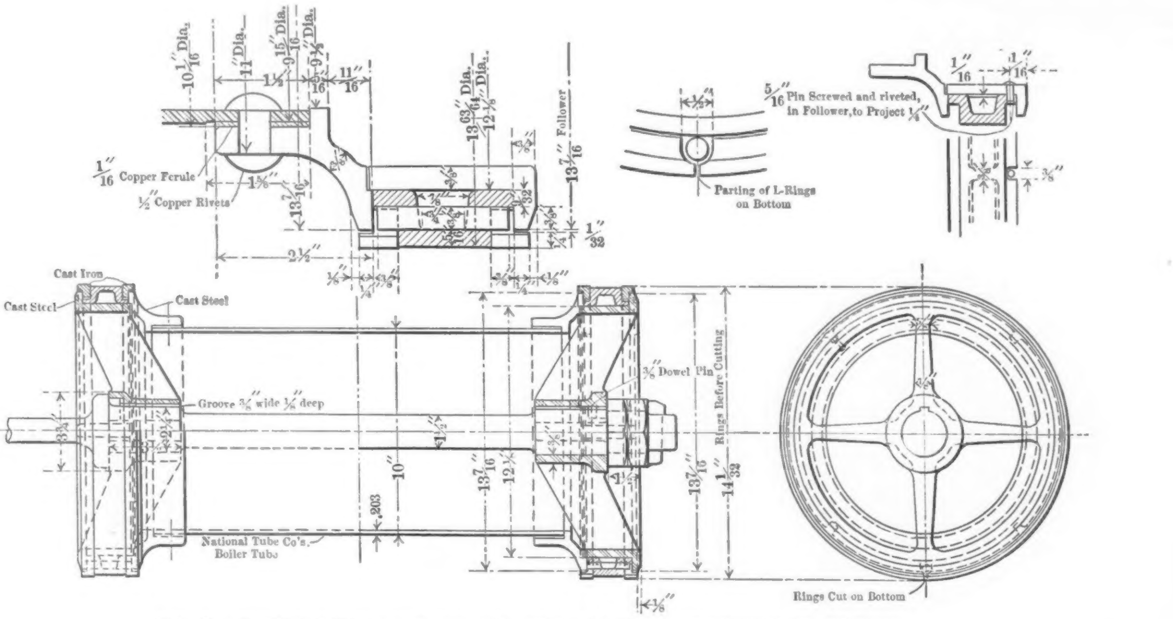

FIG. 7.—PISTON VALVE USED ON THE COLE BALANCED COMPOUND LOCOMOTIVE.

To use a solid, incompressable valve, of perfectly circular section and incapable of accommodating itself to the irregularities of the bushing, requires considerable modification in the bushing itself. In the first place it must be able to expand and contract independently of the cylinder casting; at the same time it must be held in true central position, with the steam edges of the ports always in the same relation to each other and to the cylinder itself. Moreover, at least two steam tight joints must be made on this bushing with the cylinder port walls. The valve must be of such section that it will not expand more quickly than the bushing when it suddenly comes in contact with the entering steam, and should cool at least as quickly when steam is shut off.

These conditions, together with a perfect fit between the valve and bushing, are said to have been met by the Schmidt valve, used in connection with the Schmidt superheater. This system employs for the purpose a double bushing, between the inner and outer shells of which steam has free access, joints with the port walls being made with copper gaskets. The valve is of small diameter, with a double exhaust feature. The system has been tried in this country without much success.

The form used by the Brooks Works was more successful, but has also gone out of use. In this type a single wide ring was used, with water grooves, which was cut in one place, and bolted together by means of lugs on the inside, liners between the lugs providing for accurate adjustment to the size of bushing.

The nearest thing to the plug valve in successful service is the American "Semi-Plug" valve.† It is believed that this valve could be successfully used in a bushing without bridges; and

* See AMERICAN ENGINEER AND RAILROAD JOURNAL, Oct., 1904, p. 384.
† See AMERICAN ENGINEER AND RAILROAD JOURNAL, Sept., 1906, p. 361.

aside from this fact the design is undoubtedly most successful from a point of view of maintenance. The American "Semi-Plug" valve is the only working illustration in American practice of the collapsable valve.

As a type of the modern valve, showing the lightest possible construction, combined with great strength, attention is called to Fig. 7, which is the valve used both on the high- and low-pressure cylinders of the Cole balanced compound. In this the body or spool consists of seamless steel tubing, with light cast steel ends riveted on.

Fig. 8 shows a double-ported valve for the low-pressure cylinder of a Mellin cross-compound, for passenger service. This gives the large port-opening necessary for high speed work, with very large cylinders. The prototype of this valve has long been in successful service in the engines of the battleship Texas.

Lubrication.—That the piston valve is much easier to lubricate than the slide valve is undeniable, since a cut bushing is almost unknown, while the scored valve seat is always with us. It is also true that while the piston valve is used with perfect success, with highly superheated steam, it has been found almost impossible to properly lubricate a slide valve under these conditions.

There are two methods of applying oil to the inside admission piston valve, each of which has its advocates; the first being its introduction to the center of the chest, or steam passage in the saddle, while the second involves the use of branch pipes which deliver the oil at the top of the valve itself, through a hole in each bushing. This is much more certain and economical, provided the oil holes are not spaced so widely apart that the steam ring passes over them, thereby making it dependent upon the exhaust ring to keep the oil out of the exhaust passage. The exhaust ring, as has been pointed out, is more or less unreliable, and as a result the oil is blown past it and lost both to the valve and the cylinder. The oil studs should be so spaced, when this method is used, that the valve will just wipe off the drop at the shortest stroke.

The piston valve is daily coming into more general use, as its errors are corrected and prejudice overcome. On some of our trunk lines it has practically superseded the slide valve, and it seems idle to longer deny it at least equal rank with its older competitor.

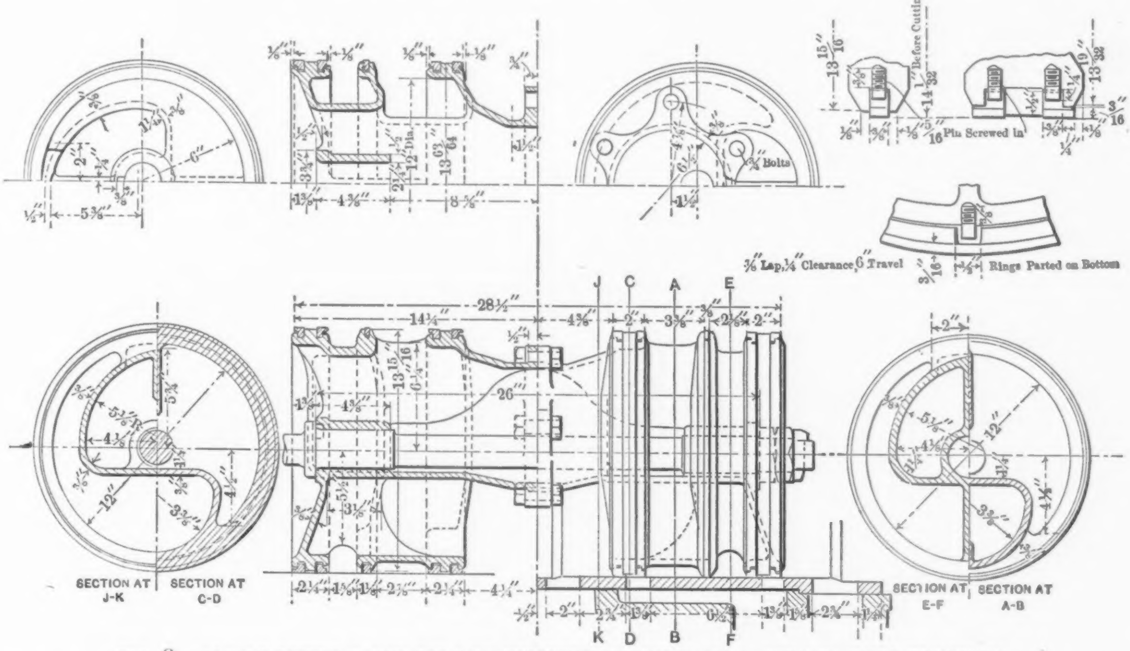

FIG. 8.—DOUBLE-PORTED VALVE FOR LOW-PRESSURE CYLINDER OF A MELLIN CROSS-COMPOUND.

MOTOR CAR DESIGN.—A motor car operated in connection with steam train service will, at times, be subjected to severe shocks, and it has been my idea to design a car of steel that would be susceptible to any sort of a shock without danger of collapsing or telescoping. With the ocean liners of ponderous weight a collision will result in a hole being punched in the side of the vessel, but, as a rule, the other parts of the frame will not be damaged; many valuable ideas may be drawn from the experience obtained in modern shipbuilding. Instead of having an underframing of excessively heavy sills with a light cracker-box framing above, we have endeavored to make the whole car body a unit structure, heavy parts of which brace its adjacent members, and in case of a wreck every bit of steel in the car would be utilized in offering resistance. Thus, our underframing comprises but one moderately heavy center sill; the side sill is a light weight continuous channel extending around the body of the car. From this outer channel bar we have continuous steel ribs running up the side through the roof and down the other side of the car; these are braced to each other by suitable cross-braces. The sides of the car form a truss; the plate of the car being the top chord and the sill being the bottom chord. This framing is well tied together at all points, and is further reinforced and strengthened by the sheet steel covering. The ends of the car are enormously strengthened by the round shape at the rear and the pointed lines in front. In a collision this car could be punctured or bent, but it could not be telescoped.—*Mr. W. R. McKeen, Jr., before the New York Railway Club.*

ELECTRIC LIGHTING OF TRAINS, whether the current is generated by a steam engine and dynamo in the baggage car, or whether the generators are driven from the axles of the cars, results in an increased coal consumption by the locomotive. The Northwestern Limited trains between Chicago and St. Paul are lighted by the former method, the current in use during the evening representing about fifteen kilowatts, or twenty horse-power. If each car is lighted with 600 candle-power, there will be about 2,400 watts required, or, say three horse-power per car, and this will represent in round numbers about fifteen pounds of coal per car per hour.—*William Penn Evans before the Pacific Coast Railway Club.*

Mr. Ruben Wells, after twenty years' service as superintendent and manager of the Rogers Locomotive Works of the American Locomotive Company, has resigned. Mr. Wells started his railway service as an apprentice in the Philadelphia & Reading shops at Reading and in 1852 went to Shelbyville, Ind., as master mechanic of several roads, which were afterwards consolidated as the Jeffersonville, Madison & Indiana Railway, with which company he remained for twenty-five years, during five years of which he was a trustee of Purdue University. In 1878 he went to the Louisville & Nashville Railway as superintendent of machinery, afterwards being promoted to the position of general manager, and in 1885 was made assistant to the president. In 1887 he left this road to become superintendent of the Rogers Locomotive Works, of which he was made manager in 1900.

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.*

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CONTENTS

* Illustrated articles.

What is the matter with the compound? What is the matter with the superheater? What is the matter with a feed-water heater? What is the matter with a variable exhaust nozzle? Well! what is the matter with them? One authority states that they are not "fool proof," *i. e.,* they will not operate successfully without attention, and hence are not suitable for American locomotives. There is no doubt but what any or all of these things will increase the capacity of our locomotives and our firemen, but we can't take advantage of the opportunity because we can't take care of them. Is this true?

The practice of reading the committee reports and individual papers in full at the Master Mechanics' and Master Car Builders' conventions should be discontinued. The men who are in a position to intelligently discuss these papers before the convention are those who have studied the paper beforehand. The chairman of the committee should in a clear manner present a very brief extract of the report in introducing it. Much valuable time is lost and the members present are often wearied by the useless reading of a long report or even of any considerable portion of it.

The piston valve for locomotives has reached a stage where it can safely be called a success. In arriving at this point it has had to pass through many alterations, each small in itself and in no way affecting the basic principle, but which, when taken together, amount to practically a new device as compared to the first attempts. Its present success is built on the firm foundation of the elimination of the weak features as they appeared and the proper understanding of the lessons taught by practice. The account of this development, as given by Mr. Stafford in an article on page 174 of this issue, will no doubt be of much interest and value to our readers.

The practice of changing driving wheel tires in the roundhouse when the locomotive is not ready to go into the back shop for heavy repairs is followed with very satisfactory results on a number of roads. The ordinary practice is to shrink the tires on a pair of wheel centers and turn them in a driving wheel lathe. The labor cost of putting a pair of tires on the centers and removing them after they have been turned would amount to at least 40 cents and the cost of the gasoline for this purpose would come to about $1.50. The actual labor cost of turning the two tires will, of course, vary in different shops, but in one shop it costs $1.50 a pair. It was found after careful investigation that the tires could be turned on a boring mill at a cost of 80 cents apiece as against $3.40 per pair or $1.70 apiece, as above. The boring mill was not of very recent design and was not equipped with a universal chuck. Two tools were used. On a modern heavy-duty mill equipped with a universal chuck this work could probably be handled to still better advantage. The space occupied by such a mill would not be greater than for a driving wheel lathe and the first cost of the boring mill would probably be less.

We are informed that an effort will be made at the Atlantic City conventions to prevent the sessions from being disturbed by noise from the exhibits or by the moving of material in the vicinity of the meeting hall. If this is done it will be greatly appreciated by the members who attend the convention. The way in which previous conventions have been disturbed is shameful. It is rather strange that some of the supply men who are trying so hard, otherwise, to make a good impression should so far forget themselves as to carelessly disturb the deliberations and cause a great annoyance to members. If the individual members of the associations will take the trouble to personally show their displeasure at occurrences of this kind there is no question but that the exhibitors will realize that their cause can be hurt a great deal more by such conduct than by all of their efforts to produce a good impression. If the exhibitors

will not honestly try to remedy this trouble it is apparently up to the railroad men to force them to do so. The work of these associations is too important to have it hampered or interfered with on the way and it it earnestly hoped that some decisive step will be taken to stop it.

A number of railroads, which up to this time have used wooden equipment exclusively, are seriously considering the introduction of steel cars. The purpose of the rather extensive article on the maintenance and repair of steel freight cars, in this issue, is to show, as clearly as possible, the advantages of steel cars from the standpoint of maintenance and repairs and the ease with which they may be repaired with almost no special facilities. Through the courtesy of Mr. J. E. Muhlfeld, general superintendent of motive power of the Baltimore & Ohio Railroad, we were enabled to make a careful and extended study of this question on that road, and trust that the results may be of value to those who are considering the introduction of such equipment or are interested in its design or maintenance. Those roads which are introducing steel equipment should benefit by the experience of those which have used steel cars for a considerable time. The experience of such roads apparently indicates that it is poor policy to attempt to reduce the dead weight of the car to too great an extent, as the additional first cost and the cost of carrying the increased weight is more than offset by the increase in repair costs.

The circular of inquiry sent out by the Committee on Subjects of the Master Car Builders' Association should meet with the hearty approval of every member of that organization, and this approval should be demonstrated in a practical way by assisting the committee in its effort to place the work of the association on a higher plane. The substance of the circular is as follows:

"The Committee on Subjects believes that the lists presented heretofore have often included a number of subjects which related to small, unimportant details and difficulties experienced only by a limited number of the members. Subjects for investigation by the committee should relate to matters of large importance and should be such as will require the committee to make extensive investigations on their own account and not to simply ask questions and print answers. The members are requested to give more careful attention to the replies to this circular than have usually been given, for the fact is often lost sight of that the program for the convention, which is largely made up of recommended subjects, occupies a large part of the attention of the convention, which is held at a great expense, and which should result in as much useful work as possible. Subjects as announced in the program have been too brief and they should be accompanied by instructions to the committee telling what is expected of them and always, if possible, leading to some positive conclusion or recommendation as a standard or recommended practice of the association."

* * * * * * * * *

In this connection it is suggested that the Association should give more attention to steel freight and passenger car equipment. All-steel freight cars have now been in service in large numbers for eight or nine years and yet the Association has given them practically no attention, other than the drawing up of a schedule of prices for repairs. Meanwhile the number of these cars has been steadily increasing until, at the present time, there are several roads upon which as much as from 20 to 50 per cent. of the freight equipment is of all-steel construction.

Conditions at present are such that it is almost impossible, in many districts, to secure proper timber for car building, regardless of the price, and on many roads timber is being used which six or seven years ago, or even less, would have been rejected. For certain classes of service, the all-steel equipment is coming into general use and it would seem advisable for the Association to place as much information, as possible, on record concerning these cars, to assist the members at large and especially those who will have to go into the matter of steel equipment in the near future. That such information will be timely is indicated by the fact that a number of Western roads have recently sent their representatives to Eastern roads who have steel car equipment, to investigate the utility of these cars and the methods of repairing and maintaining them.

Although a large number of steel cars have been in continuous operation for the past seven or eight years the opinion still seems to prevail, in some quarters, that the side and floor sheets of these cars will have a useful life of only about ten years or less. As a matter of fact cars which have been running under adverse conditions this length of time are still in good condition, and will undoubtedly give good service for several years more. The Association could profitably investigate the question of the design and maintenance of these cars with a view to gaining the best results both as to increased life and service requirements.

It is a great many years since a locomotive fitted with a feed-water pump has been illustrated in this journal, but such a design has recently appeared on one of the prominent railway lines in England, and is shown in this issue. This pump naturally differs as much from the pump in use 15 or 20 years ago as the locomotive itself differs from its predecessor at that time. In this case it is entirely independent of the running gear of the locomotive and consists of a small upright double-acting duplex pump fastened to one of the frame braces, in such a location that it is fed by gravity from the tender. Its operation is controlled by the control of its steam pressure in the cab and can be as finely adjusted to the running conditions of the locomotive as can an injector. It discharges through a feed-water heater in the front end and a check valve on the front tube sheet.

The use of a pump was necessitated in this case by the desire to use hotter feed water than can be successfully handled by an injector. The exhaust steam from the pump is condensed in the feed-water tank, which water is also further heated by a supplementary connection from the exhaust passage in the cylinders. In this way the feed water, if desired, can be heated up to 212 degs. before reaching the pump and afterwards by a proper design of heater or economizer in the front end can be put into the boiler at nearly the temperature of the water in the boiler, almost all of which heat is obtained from a supply that is ordinarily entirely wasted, *i. e.,* exhaust steam and front end gases.

From experiments which have been made of the temperature at different points of the locomotive boiler it is easy to believe that the injection of feed water at practically the temperature of the water already in the boiler will tend toward a material reduction in boiler repairs. Furthermore, the heat that enters with the feed water naturally does not have to be supplied from the heating surface of the boiler, thus resulting in a material saving in fuel.

It is interesting to examine, for a special case, what this saving might actually be. The total heat in one pound of steam at 200 lbs. pressure is about 1,200 B. T. U. The temperature of the water in the boiler, 200 lbs. gauge pressure, is about 387 degs. and assuming a temperature of feed water at 60 degs., if this feed water is heated to 300 degs. before being put into the boiler, we have added 243 B. T. U. or over 20 per cent. of the total amount of heat required in changing the feed water at 60 degs. into steam at 200 lbs. pressure, all of which heat, with the exception of that rejected by the pump, has been obtained from that ordinarily wasted. With the injector, on the other hand, the heat that is put into the feed water is all taken from the live steam in the boiler and hence there is no gain from waste sources, nor is the feed delivered at anywhere near the temperature of the water in the boiler.

In considering this question, it should not be forgotten that a feed-water heater which would give the temperature assumed above will also act as a feed-water purifier and much of the scale-forming impurities will be deposited on the tubes of the heater. This would be hard on the heater, but a good thing for the boiler.

EQUALIZERS ON PASSENGER TRUCKS.

To the Editor:

Referring to the communication on page 102 of the March issue of your journal on "Equalizers on Passenger Car Trucks." If we remove the equalizers from our passenger car trucks and put blocks between boxes and frame, we would practically have a caboose truck or a freight car truck with elliptic springs, and anyone who ever rode in a caboose knows the bad riding qualities of such a truck. On the other hand, everyone knows the smooth riding qualities of a six-wheel truck, and this is brought about by the greater equalizing effect as the same number of springs are generally used in six-wheel trucks as are used in four-wheel trucks. If we were able to remove the equalizers

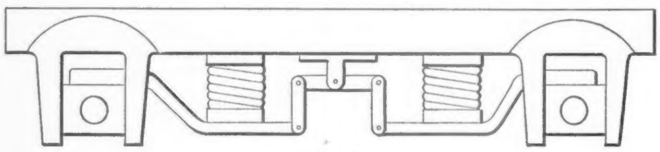


Fig.1

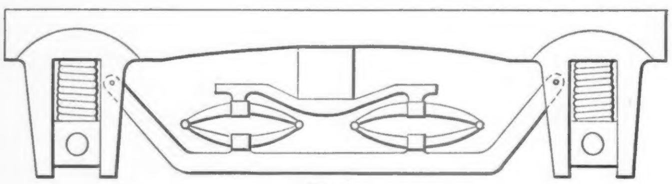


Fig.2

from passenger car trucks and get the same results, we should for the same reason be able to remove the equalizers from our locomotives which every locomotive expert knows is impossible, otherwise they would have been removed long ago, as they are a great deal more expensive both as to first cost and maintenance, than passenger truck equalizers.

I have in mind, at present, some Mogul engines which were under my jurisdiction, that rode so rough that some engineers refused to go out on them, and they were continually breaking springs and spring rigging. These engines were not equalized between the drivers, only from front driver to truck, and after a careful investigation we placed equalizers between all wheels, making a continuously equalized spring rigging. Following this change they were the best rigging engines on the road. I do not know why the same should not be true on passenger trucks.

I inclose two sketches of patented devices in which the intention was to get an equalizing effect on a four-wheel truck equal to the six-wheel truck, I do not remember the patentee of the arrangement in Fig. 1, but Fig. 2 is the Standard Car Truck Company's truck.

In my opinion, on account of the roughness of some of our roads, what we want is more equalization instead of reducing it. The cause of easy riding of European cars is mainly because of the perfect condition of the roadbed and its perfect maintenance, and the trucks are also much lighter on account of the much lighter weight and smaller size of cars.

Yours truly,

Indianapolis, Ind. B. D. Lockwood.

STEEL BOX CARS.

To the Editor:

I would like to ask a few questions about the all-steel box cars of the Union Pacific type, as built at the Omaha shops, and illustrated in your April issue.

1. What is going to happen when the steel side and floor plates become damp from either the material carried or from frost? It must be remembered that no sunlight can dry out the inside of a box car as it can a steel flat, or gondola car.

2. What will be the result when these side or bottom plates do become rusted and pieces of rust drop off into a cargo of grain?

3. In view of the above possibilities, should not a light wooden flooring be laid over the steel floor plates and light wooden posts be bolted to the T-iron posts and a light wooden inside lining be nailed to them? If wooden grain doors were provided this would keep any of the material being carried from touching the steel in any place. All of the above wood could be of the fireproof variety if thought necessary.

I ask the above questions in view of the fact that the standard box car of to-day is available for lading of practically all kinds and I am afraid that a steel box car of this design would not fulfil the same conditions and would be available for only certain limited classes of freight, which as a general proposition would be a step of retrogression instead of progress.

Another feature of these cars that should receive attention, which it apparently has not received in the design shown, is the matter of ventilation. Such a car as has been built by the Union Pacific when closed and sealed would in hot weather simply become a bake oven with a resulting damage to certain other classes of freight which would not be subjected to the objections mentioned above. There is also the matter of sweating following the cooling down, which was mentioned in your editorial on this subject. Ventilators could easily be applied to these cars and would largely eliminate this trouble.

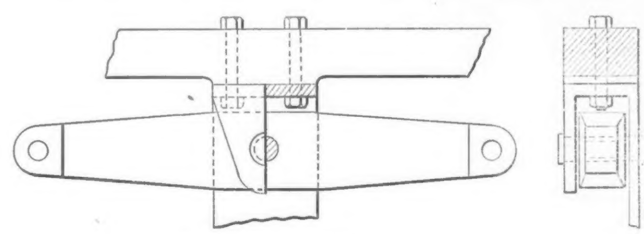
I am convinced that steel box cars will eventually supersede wooden cars, but I do not believe that they will be a tightly sealed box with no inside ventilation or insulation.

New York City. John A. Teufer, Jr.

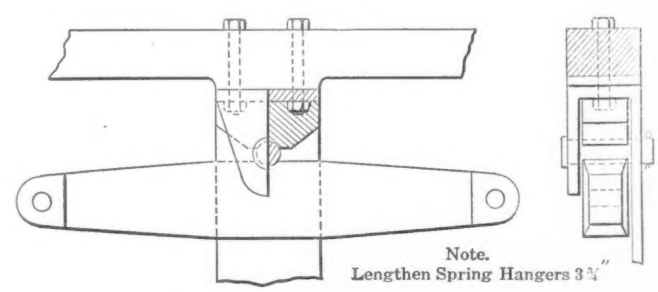
LOCOMOTIVE EQUALIZERS.

To the Editor:

There are some faulty designs in locomotive details, which, it seems to me, could be corrected at the locomotive works with no appreciable increase in first cost and with a very appreciable decrease in the later maintenance expense. These little details, if more closely attended to, and designed with foresight as to cost of maintenance, would be much appreciated by the men responsible for the upkeep of the power. At most all shops the



Present Arrangement



Proposed Arrangement

foremen are constantly making improvements or alterations to better design, and yet new engines are continually being built with the same faulty construction.

One such instance has lately come to my notice and I am enclosing a blue print showing a proposed change in locomotive spring rigging which will illustrate my point. The change as suggested will do away with boring and bushing the pin hole in the equalizer and bracket, which on account of small bearing surface in the bracket soon wears large in the present design, permitting the equalizer to ride on bracket nuts and bolt heads, resulting in loose bolts and poor equalization of weight on the springs as well as a large expense in refitting at frequent intervals.

G. D. Siemantel.

THE CENTRAL REPAIR AND MANUFACTURING SHOP

Its Advantages and Disadvantages.

By C. J. Morrison.*

(Editor's Note.—This article is based on recent observation and study of a large number of railroad shops in various parts of this country.)

The majority of the railroads have come to the conclusion that there is economy in having one large central shop which shall do the heaviest repair work and also serve as a manufacturing plant for the system. With this general conclusion in mind much work has been undertaken without careful study of various important phases of the problem.

Consider first the repair problem. Probably the item of greatest importance is the length of time an engine is out of service. To the time actually spent in the shop must be added the time waiting for repairs, and the time in transit to and from the shop. If this total time out of service is less than the total time required at the local shop, it will be an economy in point of time to send the engine to the central shop. A careful study of the records of a large number of shops on different roads shows that the large shops are able to handle an engine in from 35 to 45 per cent. less time than the smaller shops on the same road, considering time in the shop only. However, an engine often stands on the hospital track waiting for repairs a longer time than it spends in the shop, thus placing the large shop on a par with the smaller shops as regards the time element.

As a rule an engine does very little waiting at one of the small shops, but is taken out of service and placed in the shop on the same day. This difference is accounted for in several ways. First, the small shop is usually in charge of a master mechanic, who also has charge of the division upon which the shop is located, while the large shop is entirely divorced from the road and is in charge of a shop superintendent. As the master mechanic has control of the engine all the time, he is able to keep it in service, by the aid of careful roundhouse work, until he can handle it to advantage in the shop. On the other hand, the shop superintendent has no voice in the matter, and an engine may be sent to him six weeks before he can possibly find room for it in the shop. Engines are also often sent without any notice being given that they are to be shipped and without any report being made as to the nature of the repairs required. This frequently results in an engine standing in the shop for days waiting for some part, such as a cylinder or a firebox, while the material would have been ready had a proper report preceded the engine. The organization on many roads is deficient in this respect. In order that the central shop may effect an economy in the time required for repairs, the hearty support of the outside points must be given.

A scheme which is giving satisfactory results, is to assign an arbitrary mileage to each engine when it leaves the shop. As soon as a master mechanic receives an engine from the shop he assigns a mileage, based on the condition of the engine, the service expected and the division upon which it is to be operated, which it must make before it is again shopped. Thus an engine in a level country with good water may be assigned 90,000 miles while the same engine if operating in a bad water district, with heavy grades and curves, might be assigned only 60,000 miles. At the first of the month each master mechanic makes a report showing the total mileage made by each engine and the mileage yet to be made. If the mileage to be made is decreasing faster than the actual mileage is made, an explanation is required.

For example, assume that engine 1987, turned out of the shop February 1st, is assigned 90,000 miles, makes 3,000 miles during February and is shown March 1st as still able to make 80,000 miles, an explanation must be made. On the other hand, after an engine has been out several months and the mileage required is getting low, light repairs may be given to it, and the next report show an increase in the mileage required. In this case an explanation is also given. By this method a close tab is kept on the condition of the power and the approximate date when each individual engine is to be shopped is known. Space in the shop is reserved accordingly and material is gotten ready in advance. Wrecks alone interfere with this scheme, but as a certain allowance is made for these, no serious disadvantage is caused.

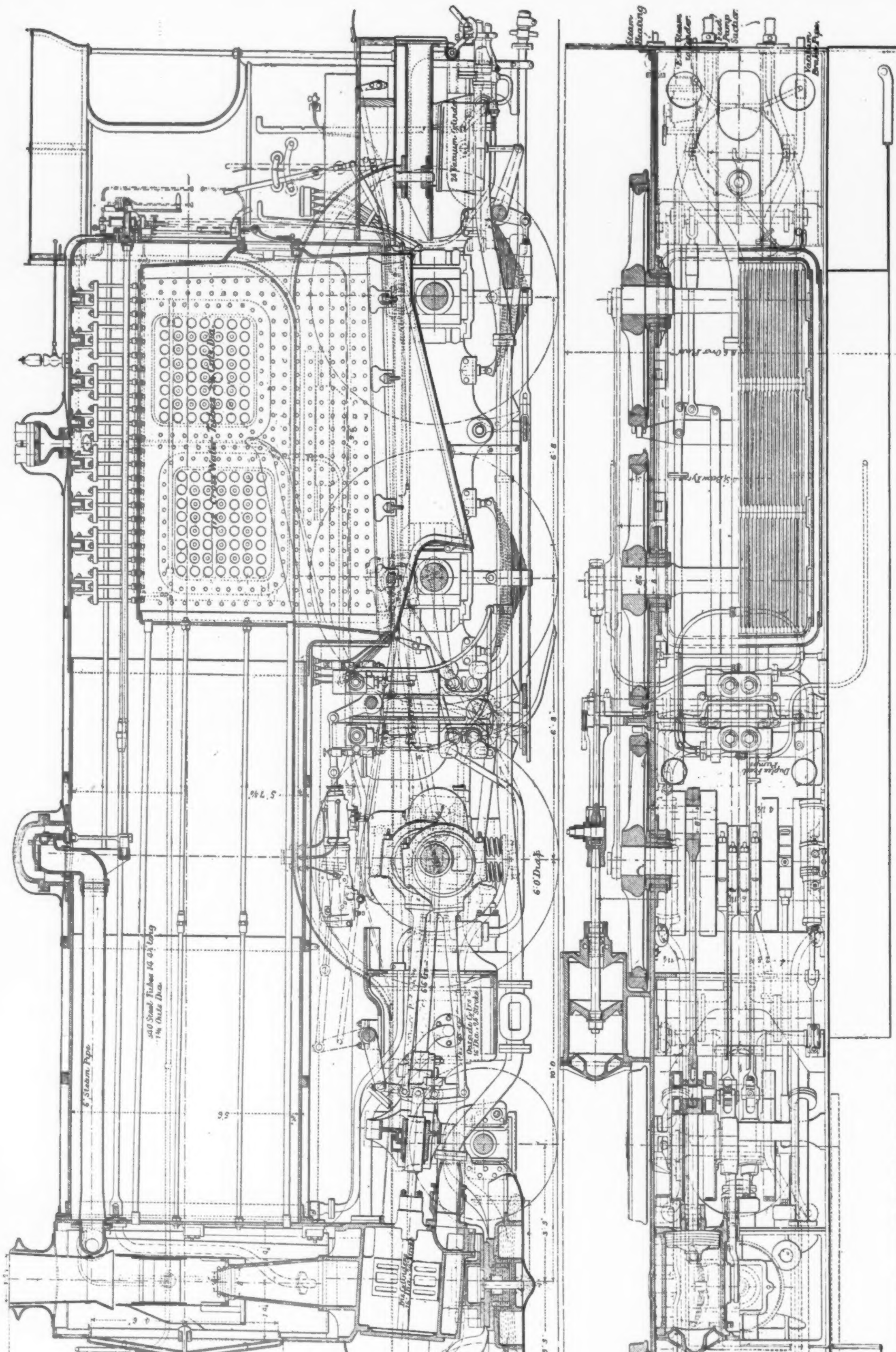
In the matter of cost of repairs the large shop is found to be able to do the same work at from 20 to 35 per cent. less, including surcharges, than the smaller shops. This is largely due to the organization possible in the large shop. Here men become specialists and do their own particular work in a time impossible to the all-around man in the smaller shops. However, the large shop will not be able to effect this saving unless standard parts and specifications are adopted and strictly adhered to. Each shop must be required to finish material to standard and to erect and maintain the engines to standard specifications. It is a very common practice on some roads for an engineer, road foreman or master mechanic to change engines from the standard. Not only this, but the different shops on a system often finish material and erect engines according to their own ideas. This adds greatly to the expense of maintenance as an engine must be made standard again when it changes divisions or when it goes to the general shop. In some cases the added expense is as much as threefold. Assume, for instance, that a new engine just received from the builder, standard in every detail, is altered by some master mechanic, makes its mileage and is sent to the general shop. As the shop has no authority for the changes, the engine is erected to standard prints, and returns to the division from whence it came. Here it is again altered. If engines are changed from standard so that each engine becomes a problem in itself, the advantage of the specialists is largely eliminated.

From the manufacturing standpoint the importance of standards becomes even more evident. The large shop is placed practically on a small shop basis if articles must be made to different specifications for each point on the road. Economy is obtained only when each article is made in large quantities. Not only is this true concerning the actual manufacture, but the stock required becomes smaller as the number of different patterns decrease. On some roads it is the practice for each division on a system to have its own standards and its own methods. This means that the central shop must manufacture separately for each division and also that finished material cannot be transferred from one division to another, but that each must keep its individual stock. It also means that unless great care is taken, articles manufactured for one division will be shipped to another where they will be practically useless. To prevent such mistakes the cost of supervision is increased.

The practice of manufacturing at one central shop and shipping material to the smaller points ready to apply has, in many instances, raised the cost of repairs. This increased cost was brought about by the application of new material where the old parts should have been repaired. Instances are recorded where entire new driving boxes have been applied instead of new brasses being pressed into the old boxes. New shoes and wedges are put up to avoid lining the old ones, and, in one extreme case, a new four guide crosshead was applied to avoid thirty minutes' lathe work on the old one. Examples of these practices are not confined to any one system, but have been observed on large roads all over the country. Such work can be eliminated by careful supervision and by impressing on the foreman the cost of each article.

It is obvious that the central repair and manufacturing plant will be an economy only when standards for parts and for erecting are adopted and strictly adhered to, when engines are required to make a specific mileage, when careful inspection reports precede an engine to the shop, when the shop is notified in advance when such engines will be shopped, and when the waste of material is eliminated. The last clause should be understood to include stopping the practice of robbing an engine before it is sent to the central shop.

* General Erecting Foreman, Topeka Shops, Atchison, Topeka & Santa Fe Railway.



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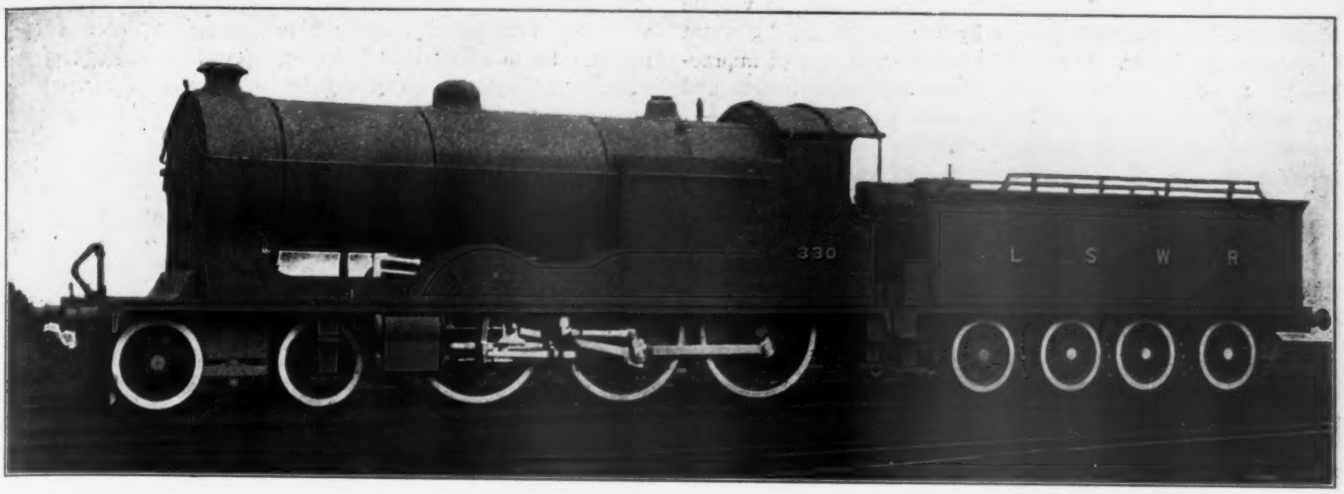
SECTIONAL ELEVATION AND PLAN OF FOUR-CYLINDER SIMPLE LOCOMOTIVE—LONDON AND SOUTHWESTERN RAILWAY.



FOUR-CYLINDER SIMPLE LOCOMOTIVE—LONDON AND SOUTHWESTERN RAILWAY.

FOUR-CYLINDER SIMPLE TEN WHEEL LOCOMOTIVE.

LONDON AND SOUTHWESTERN RAILWAY.

By CHAS. S. LAKE, A. M. I. Mech. E.

The London and Southwestern Railway has had in service during the past 18 months, a class of four cylinder simple locomotives of the ten-wheel type built from designs prepared by Mr. D. Drummond, locomotive superintendent, which, in view of the very general interest being taken in this type of powerful. high speed locomotives, offer many points of interest.

The four single-expansion cylinders are arranged as in the de-Glehn compounds, viz.: with one pair inside the frames, below the smokebox, driving the crank-axle of the leading pair of drivers, and the outside cylinders set back of the truck and connecting to the middle drivers. The cylinders are all 16 x 24 in. and two separate sets of valve gears are provided, the inner one being of the Stephenson type and the outer of the Walschaert. The driving wheels are 72 in. diameter and the total weight in working order is 163,520 pounds. The tractive effort figured as two simple engines is 25,300 pounds.

These locomotives have been designed primarily for dealing with the heavy and fast passenger trains comprised in the principal express summer services of the London & South-Western Railway. They are employed on the west of Salisbury division and chiefly between that place and Exeter, where heavy and continuous grades are met with. Some of these have an inclination of 1 in 70, and the one which reaches its summit shortly after clearing Honiton tunnel is 10 miles long; the highest point being 470 feet above sea level.

The principal "West of England" expresses of the London & South-Western Railway consist during the summer months of seven 30-ton corridor cars and one 40-ton dining car. The trains are vestibuled throughout and weigh loaded about 280 tons, exclusive of engine and tender. The new 4-6-0 type 4-cylinder locomotives were used for the first time on this traffic during the summer of 1906. They worked the trains regularly between Salisbury and Exeter and *vice versa*, a distance of 88 miles; the average speed being 52 miles per hour. The coal consumption during the heaviest period of service, viz., July, August and September, averaged 40 lbs. per mile, the lowest rate being 35 lbs. and the highest 47.3 lbs., and evaporation of water was at the rate of 10 lbs. per pound of coal burned.

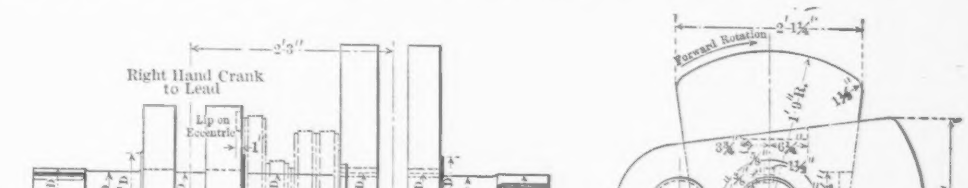
During the winter of 1906-7 the engines have been employed hauling special freight trains running on a fast schedule between Salisbury and Exmouth Junction (Exeter). These trains make one intermediate stop of 30 minutes' duration at Yeovil Junction, and they are allowed 4 hours 6 minutes gross, or 3 hours 36 minutes net running time in which to perform the journey. The trains are comprised of 45 to 50 loaded cars of miscellaneous types, the total weight of train varying from 600 to 700 tons behind the tender.

The cranks on the front axle are, as will be seen in the illustrations, of the balanced type having large projections opposite the crank pins; there are no weights cast with or attached to the wheel centers, these being unnecessary, as all the revolving weights are balanced in the axle and in the planes in which the larger part of the disturbances are created. The stresses are kept more nearly in line when axles are constructed in this way and a much easier running engine results.

The crank-axle is of mild steel of the built up design, the webs being in one piece with the balance weights. The throw of the cranks is 12 in., but that of the coupling rods is only 10 in. The crank pins and coupling-rod pins for the outside cylinders are in one piece, but are turned to different diameters with 2 in. of eccentricity.

The outside cylinders are each connected to the frame by a box casting or distance piece, which locates the cylinder center properly in line with the crank-pin of the middle drivers. This casting is made considerably shorter than the cylinder itself, so that it fits closely in between the rear truck wheel and front driver, whereas the cylinder itself overlaps the latter. Incidentally this permits of the total wheel base being shortened, inasmuch as the leading drivers are brought closer up to the truck than could be done if the outside cylinders were bolted to the frames for their entire length. The inside cylinders are inclined at 1 in 14, their axes intersecting the center of the crank-axle, which is driven through connecting rods 6 ft. 6 in. long.

The four cylinders are each 16 in. diameter, giving a total piston area of 804 square inches, with a piston stroke of 24



CRANK AXLE—FOUR-CYLINDER SIMPLE LOCOMOTIVE.

inches; thus we find they are in the aggregate equal in volume to two cylinders of 22 in. diameter by 26 in. stroke taking steam direct from the boiler. It would be a matter almost of impracticability to fit two such large cylinders inside the frames and their arrangement outside the frames could only be accomplished at some inconvenience to come within the width allowed by the British gauge limitations.

The exhaust ports are 3 in. wide and steam ports 1¼ in. The port faces of the inside cylinders are at the sides so that the two slide-valves work back to back between the cylinders, but the outside slide-valves work underneath the cylinders.

Reversing the valve-motions is done by means of a combined arrangement actuating all four gears simultaneously and operated by a steam and hydraulic device, the cylinders of which may be seen in the drawings located just inside the frame on each side of the engine, above the crank-axle. The steam supply to all four cylinders is controlled by one throttle valve and all exhaust through the same exhaust pipe.

An engine having the cylinder proportions of this one needs ample boiler capacity to ensure success, and in this respect the designer has gone practically as far as is possible within the loading gauge. The boiler barrel has an internal diameter of 5 ft. 6 in. at the front and is 14 ft. 2 in. long between tube plates. It contains 340 steel tubes 14 ft. 4½ in. long by 1¾ in. outside diameter, and 13 S. W. G. thickness.

These tubes provide 2,210 sq. ft. of heating surface, all of which may be regarded as effective as their length is moderate and the special spark arresting and fuel economizing device located in the smokebox tends to retard the passage of the gases through the tubes and creates an equal draught through all of them. Much valuable heat which would otherwise pass away into the atmosphere unabsorbed is thus retained in the boiler in contact with the surfaces prepared to receive it. The boiler barrel tubes are supplemented by two groups of water tubes across the firebox. These have an outside diameter of 2¾ in. and, in the aggregate, number 112, giving an additional heating surface of 357 sq. ft., which, added to the 160 sq. ft. of the firebox plates, and the 2,210 sq. ft. of the ordinary fire tubes, brings the total heating surface of the engine up to 2,727 sq. ft.—an unusually large amount for a British locomotive. The grate area is in proportion, viz., 31.5 sq. ft., and the working steam pressure is 175 lbs. per sq. in.

The cross water tubes in the firebox are inclined from side to side, one group sloping from left to right and the other group in the opposite direction. This ensures thorough circulation of the water and conduces to extreme rapidity in steam raising. The rectangular projection seen on the side of the firebox in the photograph is a covering plate for the hinged doors which give access to the ends of the water tubes on each side. Apertures are formed in the outer shell of the firebox and a steel casting riveted on around each, these castings being faced to form a joint with corresponding faces on the doors, the two being drawn up tightly together by means of studs and nuts placed all round the outside of the faced joint.

With a view to still further increasing the efficiency of the boiler Mr. Drummond has added a feed-water heating apparatus. No injectors are used for feeding purposes; their place being taken by two duplex-feed pumps arranged tandemwise underneath the boiler in front of the firebox. They are set vertically and fastened to a steel cross stay plate connecting at each end with the main frames. The exhaust steam from the pumps is exhausted into the tender together with that portion of the main exhaust which is required to heat the water in the tank to the desired temperature. The delivery pipes connecting the tender tank and the boiler are carried through the smokebox where the feed water is further heated. The water is, by these combined means, brought to a very high temperature before entering the boiler (hence no injectors) and the pumps are properly regulated to furnish a supply of water uniform with the rate of evaporation. The pumps are kept in operation continuously and are only adjusted to meet changing gradients. It is important to note these features in the design of and arrangements connected with the boiler because hitherto the attempt to introduce the four-cylinder simple locomotive on British railways has been mainly unsuccessful owing to deficient boiler power. In this instance, however, special attention has been given to enlarging the capacity for steam generation, and with such ample cylinder proportions this is above all things necessary.

Mr. Drummond has several 4-cylinder simple engines of the 4-2-2-0 type in service, in which a leading truck precedes two pairs of uncoupled drivers. The cylinders are arranged similarly to those of the engine described above, but in place of the Walschaert gear of the outside cylinders the Joy motion is employed. These locomotives have 6 ft. 7 in. diameter driving wheels, four cylinders 14 in. by 26 in., total heating surface 1,760 sq. ft., grate area 27.5 sq. ft., and steam pressure 175 lbs.

There is also at present building at the Nine Elms Works of the London & South-Western Railway a further series of engines, to the same general design as that illustrated, but having cylinders 16½ in. diameter by 26 in. stroke in place of 16 in. by 24 in. of the "330" class. The slide-valves of the outside cylinders will, in these latest locomotives, work on top instead of below the cylinders.

The general dimensions of the "330" class are as follows:

GENERAL DATA.	
Gauge	4 ft. 8½ in.
Service	Passenger
Fuel	Coal
Tractive effort	25,300 lbs.
Weight in working order	163,520 lbs.
Weight on drivers	114,360 lbs.
Weight on leading truck	48,160 lbs.
Weight of engine and tender in working order	263,984 lbs.
Wheel base, driving	13 ft. 4 in.
Wheel base, engine and tender	53 ft. 2 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.5
Total weight ÷ tractive effort	6.5
Tractive effort × diam. drivers ÷ heating surface	660
Total heating surface ÷ grate area	86.5
Firebox heating surface ÷ total heating surface, per cent	18.6
Weight on drivers ÷ total heating surface	42
Total weight ÷ total heating surface	60
Volume both cylinders, cu. ft.	11.2
Total heating surface ÷ vol. cylinders	243
Grate area ÷ vol. cylinders	2.8
CYLINDERS.	
Kind	Simple
Number	4
Diameter and stroke	16 x 24 in.
Valves	Bal. slide
WHEELS.	
Driving, diameter over tires	72 in.
Driving journals, main, diameter	8 in.
Engine truck wheels, diameter	42 in.
Engine truck journals, diameter	6 in.
BOILER.	
Working pressure	175 lbs.
Outside diameter, maximum	67⅜ in.
Firebox, length	114 in.
Tubes, number and outside diameter	340—1¾ in.
Tubes, length	14 ft. 4½ in.
Water tubes, number and diameter	112—2¾ in.
Heating surface, tubes	2,210 sq. ft.
Heating surface, firebox	160 sq. ft.
Heating surface, water tubes	357 sq. ft.
Heating surface, total	2,727 sq. ft.
Grate area	31.5 sq. ft.
Smokestack, height above rail	13 ft. 2½ in.
Center of boiler above rail	108 in.
FEED PUMPS.	
Diameter of steam cylinders	4½ in.
Diameter of water cylinders	[illegible] in.
Stroke of both cylinders	8½ in.
TENDER.	
Water capacity	4,000 gals.
Coal capacity	4.5 tons
Heating surface of heater	382 sq. ft.

Cast-Iron Car Wheels.—There is not another essential part of the freight car equipment which costs the railroad companies so little money compared with the service rendered as does the cast-iron car wheel. The 600 lb. wheel costs about $10.80 new, and after giving a mileage of 40,000 to 70,000 it is turned back to the foundry at a scrap value of about $7.80, giving a cost per 1,000 miles of about 5 cents.—*Mr. W. E. Fowler before the Canadian Railway Club.*

Foaming Waters.—For each pound additional foaming matter per 1,000 gallons of water, the increased expense would be equal to the cost of pumping and treating at least 70 gallons of water, and the fuel for heating it to the temperature of boiler water. In addition to this expense, there would be the damage incurred to boilers by introducing cold feed water to replace water blown out, with the consequent cooling of tubes and sheets. —*Report of Committee, Amer. Ry. Eng. & M. of W. Assoc.*

TONNAGE RATING.*

BY J. E. MUHLFELD.†

Locomotives suitable for the handling of trains of the greatest permissible tonnage, at the maximum allowable speed over the different operating divisions, should be used and loaded with a reasonable remaining surplus of power to prevent liability of trains failing to make schedule time. Locomotives of great power have too often failed to meet the requirements on account of being attached to trains of greater resistance, as practical experience has now demonstrated that steam locomotives of 70,000 pounds tractive power can be as satisfactorily maintained and operated for hauling freight as those of one-half the capacity.

Speed and grade are factors that largely control the loading of locomotives as well as the cost of their operation. Running speeds of 15, 20 and 25 miles per hour are more economical than speeds of 10, 30 and 35 miles per hour. In general freight locomotives handling low class tonnage should be loaded to haul trains at an average schedule speed between terminals, including road delays, of from 12 to 15 miles per hour, on low grade, and of from 10 to 12 miles per hour on high grade lines, which is as fast as economy will allow. This will require a running speed of 20 miles per hour over a division, except on the ruling grade where they should be loaded to maintain a running speed of 8 miles per hour, unless the grade is over 2 miles in length, when they should be loaded to maintain a running speed of from 10 to 12 miles per hour. On a fairly level division, with considerable curvature, it may be necessary to reduce the loading on the ruling grade in order to maintain 20 miles per hour over the other portions of the division, in which case the rating of the locomotive for 20 miles per hour is the ruling factor. In rating locomotives the tonnage determined upon should be such as will give the same resistance behind the tender, which is not necessarily the same dead weight.

The hauling capacity behind the tender of a simple cylinder freight locomotive, having a ratio of not less than 4 between tractive power and weight on drivers, and operating on straight, level track at a speed of 8 miles per hour may be represented by the following formula:

$$H = \frac{d^2 \times s \times .8p}{D} - 10\ W \text{ in which}$$

H = maximum hauling capacity in pounds at rear of tender at a speed of 8 miles per hour.
d = diameter of cylinder in inches,
S = stroke of piston in feet,
p = indicated boiler pressure in pounds,
D = diameter of driving wheels in feet.
W = weight in tons of engine and tender in working order, including full load of coal and water.
10 = rolling resistance per ton of locomotive in pounds at 8 miles per hour.

From the maximum hauling capacity, so derived, the available hauling capacity, at any desired speed above 8 miles per hour that will give between 250 and 650 feet of piston speed per minute, can be determined by the following formula:

In which $A = H\ [1. - (P - 250)\ .001]$.

In which $P = 56.022\left(\frac{R \times S}{D}\right)$

H = maximum hauling capacity, in pounds, at rear of tender at a speed of 8 miles per hour;
D = diameter of driving wheels, in feet;
S = stroke of piston, in feet;
R = desired running speed, in miles per hour;
P = piston speed, in feet per minute;
A = available hauling capacity of locomotive, in pounds, behind tender at desired speed.

From the available hauling capacity so derived must be deducted a resistance of 2 pounds per ton for each .1 per cent. of grade and 2 pounds per ton for each degree of curvature not compensated, using this adjustment for the combination of grade and curvature that produces the maximum resistance on the division over which the locomotive is to be operated, after which the rating may be calculated as follows:

On a straight, level division, at a running speed of 10 miles per hour, a loaded 100,000 pounds capacity car has a resistance of about 5 pounds and a loaded 60,000 pounds capacity car of about 6 pounds per ton. When empty both cars have a resistance of about 9 pounds per ton. For each 5 miles per hour increase in running speed up to and including 20 miles per hour, 1 pound per ton; for each .1 per cent. of ruling grade, 2 pounds per ton, and for each degree of ruling curvature not compensated 7-10 pound per ton should be added for additional resistance. The adjustment for gradient and curvature should be for such combination as produces the maximum resistance on the division over which the train is to be operated and curves on grades compensated at a minimum of .035 per cent. per degree of curvature can be disregarded.

To allow for the difference in the resistance of empty, partially loaded or loaded cars, the following adjustment figures, which represent the difference in tonnage divided by the difference in number of cars as between the loading for loaded and empty car trains, should be added to the weight of each car:

Minimum	grade	15	tons	per	car
.3%	"	11	"	"	"
.5%	"	8	"	"	"
.75%	"	6	"	"	"
1.00%	"	4	"	"	"
1.50%	"	3	"	"	"
2.00%	"	3	"	"	"
2.50%	"	2	"	"	"

Different ratings should be provided for the following temperature conditions:

The maximum rating for above 45 degrees Fahrenheit.

The next rating for above 35 up to and incuding 45 degrees Fahrenheit. (Add 1 pound per ton to resistance of loaded and empty cars for rating above 45 degrees Fahrenheit.)

The next rating for above 20 up to and including 35 degrees Fahrenheit. (Add 2 pounds per ton to resistance of loaded and 3 pounds per ton to resistance of empty cars for rating above 45 degrees Fahrenheit.)

The minimum rating for 20 degrees Fahrenheit or below. (Add 4 pounds per ton to resistance of loaded and 6 pounds per ton to resistance of empty cars for rating above 45 degrees Fahrenheit.)

With heavy snow or wind, bad rails or locomotives in indifferent condition, special allowance must be made to meet the conditions.

Care should be exercised when the temperature is below 45 degrees Fahrenheit and varies during a 24-hour period that the highest permissible rating is used for runs which occupy the time of day when the most favorable temperature, rail and weather conditions may exist.

In making up trains the loaded and heaviest capacity cars should be placed ahead and house car doors should be closed and locked.

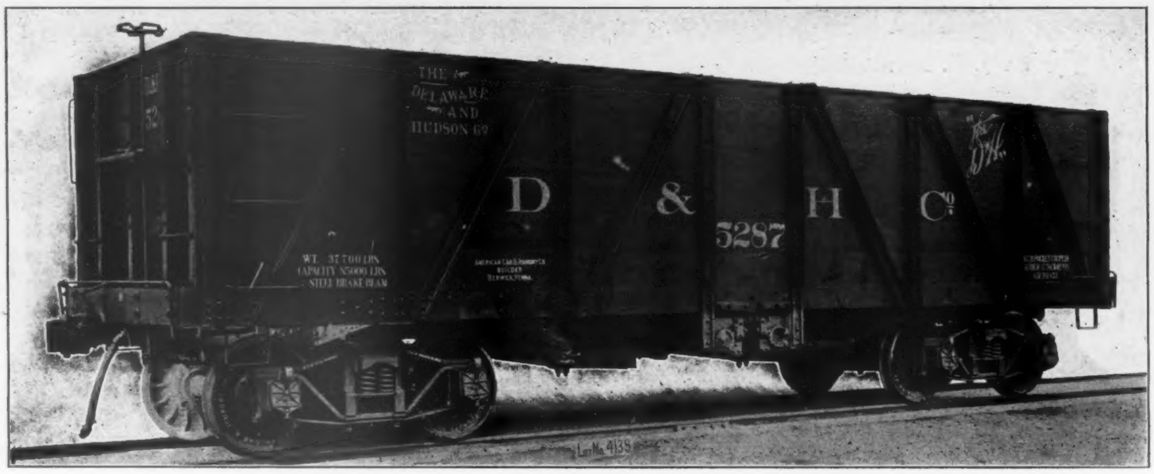
When a helper locomotive is used on a train as a double-header, 90 per cent. of the combined ratings for the locomotives should be used. When a helper locomotive is used as a pusher the combined ratings for the locomotives should be used.

Special rules must be made for special cases, as the combination of speed and load that may give the best result will depend largely upon the density and kind of traffic, length of run, operating limit for length of train, ruling and momentum gradient and curvature, reserve curves, elevation of curves, condition of rail and roadbed, main and passing trackage, water and fuel stations, slow orders, stops, fuel and locomotives.

* From a paper on "Practical Means of Increasing the Earning Capacity of Freight Cars," read before the March meeting of the Railway Club of Pittsburgh.

† General Superintendent of Motive Power, Baltimore & Ohio Railroad.

COAL USED IN STEAM HEATING.—In some tests made by the Gold Car Heating and Lighting Company on the Northern Pacific Railway in extremely cold weather, it was found by catching the drips from the cars, that sixty-two pounds of water per car per hour were obtained. Ordinarily the consumption of steam would not average over fifty pounds. Hence it will be safe to assume that ten pounds of coal are burned on the engine per car per hour, in addition to the regular amount needed for moving the train. With ten-car trains this would be one hundred pounds per hour. If leaks occur in the train pipe, as is sometimes the case, especially at the couplings, the amount will be increased.—*William Penn Evans, before the Pacific Coast Railway Club.*



COMPOSITE HOPPER CAR—DELAWARE AND HUDSON COMPANY.

COMPOSITE HOPPER CAR.

DELAWARE & HUDSON COMPANY.

The American Car & Foundry Company has recently delivered to the Delaware & Hudson Company an order of composite hopper cars of 85,000 lbs. capacity, which are a very good example of a car design in which steel is used wherever it is of particular value and wood wherever it can be placed without affecting the strength or stability of the car as a whole.

The illustrations show the features of the cars very clearly and reference to them will show many well-designed details not mentioned in the following brief general description.

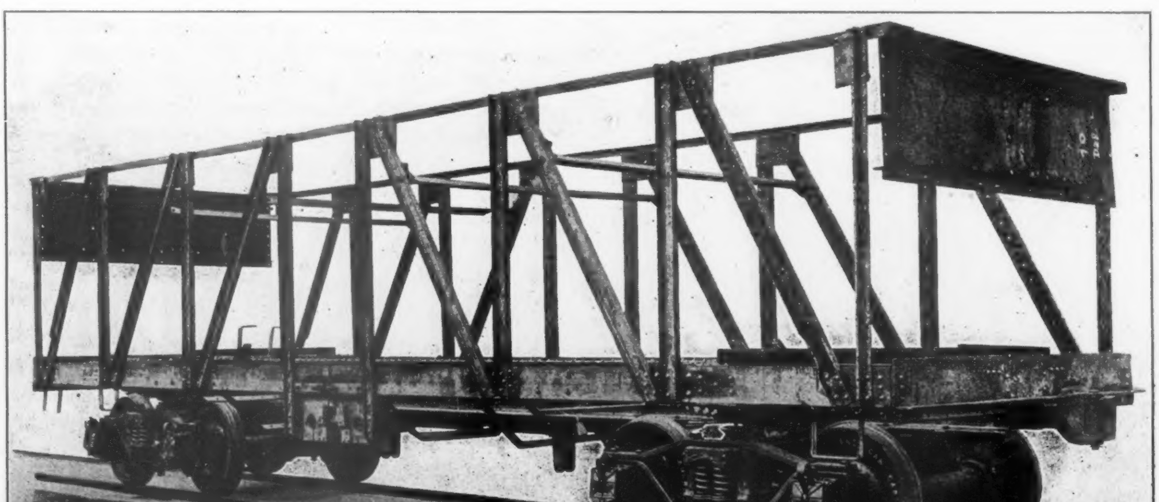
The underframe throughout, with the exception of the end sills, and the principal members of the side framing are formed of steel channels, angles and shapes, while the sides, floors, doors and end sills and posts are of wood. It is of the self-clearing design, with two hoppers, both of which cover nearly the full width of the body.

The load is carried very largely by the center sills, which consist of two 15 in. channel irons spaced 12⅞ in. apart and extending continuous between the end sills. A ⅜ in. cover plate is fastened to the top of these sills, being continuous between bolsters and a series of diagonal cross ties of 2 x ⅜ in. bars are secured to the bottom of the sills for a short distance inside the bolsters at either end. The sills are set at such a height that the draft lugs are fastened directly to the webs of the channels without the use of auxiliary draft sills. The end sills are formed of 8 x 9½ in. wood reinforced by steel angles and plates, and being but 9½ in. in depth, they pass above the coupler shank without interruption. The side sills are 8 in. channels continuous between end sills and carry a part of the load, which is transferred to them by the hopper supports and the side posts. The bolsters are built up of pressed steel filling pieces between the sills and heavy cover plates top and bottom continuous between side sills, the top plate being ½ by 12 in. and the bottom plate ¾ by 12 in.

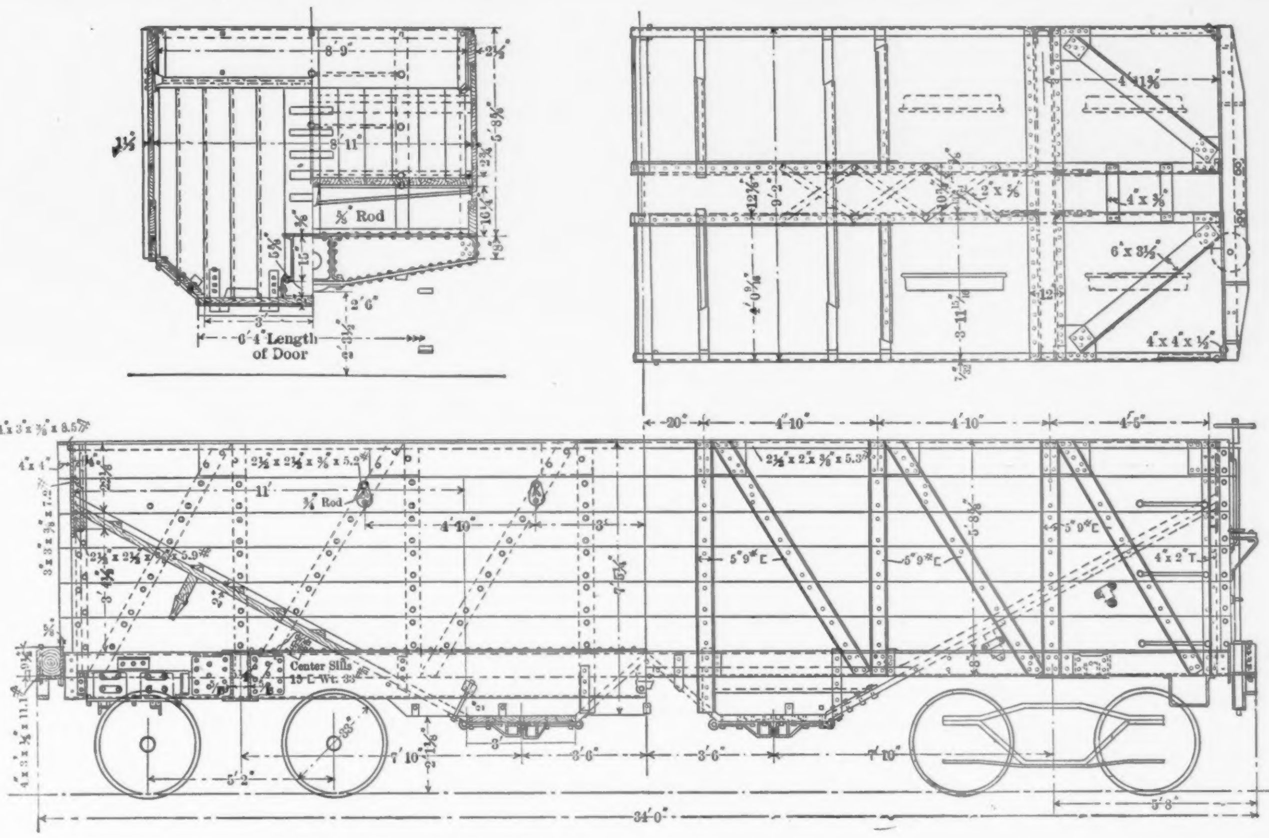
The side framing consists of 5 in. channel iron posts and diagonal members, which connect to a 2½ x 2 in. angle forming the side plate by means of gussets, the corner posts, however, are 4 x 2 in. T-irons and the end plate is a 4 x 3 in. angle. Four stiffening bars, consisting of 2½ x 2½ in. angles covering a ¾ in. tie rod are placed across between the sides, being located about 17 in. below the plate.

The floor, consisting of 2 in. plank, extends from a point 22 in. below the end plate in one plane to the outer end of the hopper opening on that end, this being 5⅝ in. below the bottom of the center sills and 2 ft. 1⅛ in. above the rail. The floor is supported at the upper ends by a cross timber resting on an angle iron, which in turn is secured to a ¼ in. steel plate forming the end of the car above this point. It is also supported by a cross timber resting on the top of the center and side sills and again by a strap iron sling secured to the side sills and passing below the hopper near the doors. It is further trussed by a ⅝ in. rod located about midway between the upper two supports.

Each hopper has a bottom opening of 3 ft. x 6 ft., which, however, is reduced by the width of the center sills, giving a combined actual opening on both sides of 3 ft. x 4 ft. 4¼ in. for each hopper. The hoppers are located 7 ft. apart and have double transverse doors formed of 2 in. plank reinforced by



STEEL FRAMING—COMPOSITE HOPPER CAR.



ELEVATION, PLAN AND SECTIONS OF COMPOSITE HOPPER CAR—D. & H. CO.

plates and bars. The doors are operated by the Dunham drop door device. The method of supporting the hopper is made clear in the general elevation and sections.

The sides, of 1½ in. plank, are fastened inside of the side framing, being bolted to the steel posts. The end posts and auxiliary corner posts of 4 x 4 timbers secured to the steel frame form the end structure of the body.

The trucks are of a simple arch bar design, with cast steel bolsters and Damascus brake beams.

The general dimensions and weights are as follows:

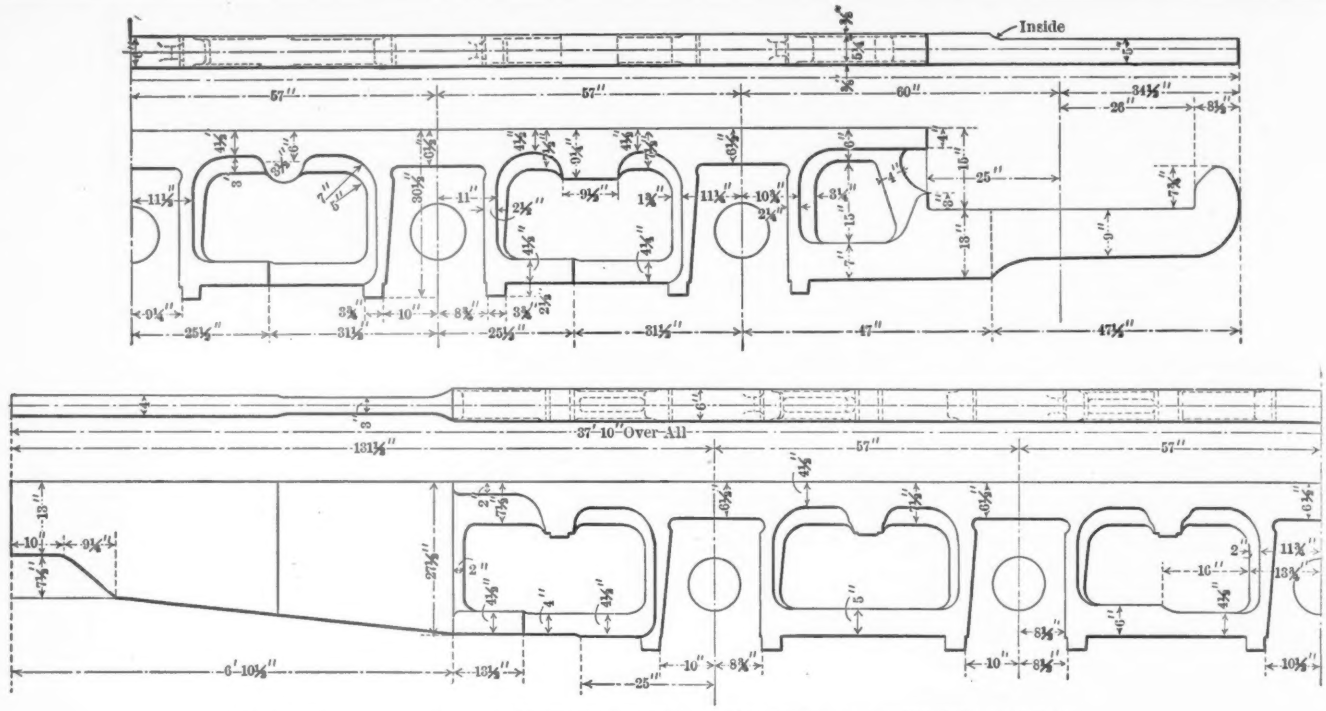
Length over end sills	34 ft.
Width over side sills	9 ft. 2 in.
Length inside	32 ft.
Width inside	8 ft. 11 in.
Height from rail to top of side	9 ft. 6⅜ in.
Height from rail to bottom of center sill	2 ft. 6¾ in.
Distance between bolsters	22 ft. 8 in.
Wheel base of truck	5 ft. 2 in.
Size of wheels	33 in.
Capacity	85,000 lbs.
Weight, light	37,700 lbs.

EUROPEAN LOCOMOTIVE DESIGN.—The following is taken from an article in a recent number of a prominent German engineering paper: One of the first features that causes comment on the part of an American examining these European locomotives is their extreme lightness and apparent delicacy of construction. The piston rods, side and main rods, all parts of the valve gear, as well as the wheels, are made of steel the tensile strength of which is much higher than any material available for such use in the United States. In the latter country, it is not only a question of the expense entailed by the use of such metal, but master mechanics and mechanical engineers are forced to admit that it cannot be procured outside of Europe. Further, in Europe, innovations on locomotives are tried out with the sole end in view of effecting economy of operation, and the enginemen as a rule take more interest in obtaining results and thus gaining premiums for themselves, than is the case in the United States. Hence the complications and cost of repairs for compound locomotives are much less than the coal saving effected by their use. The same is gradually being found out in regard to superheated steam, though it is not so clearly established as compounding, which is now standard practice in Europe.

It must be remembered, however, in considering locomotive performances, that the quality of the coal obtainable in most parts of Europe is excellent, not only the loose coal, but the briquettes that are in common use. While fuel is expensive, it is burned to the greatest advantage owing to the custom of not overloading engines, forcing fires and risking the various kinds of trouble that Americans have come to regard as unavoidable owing to their conditions of traffic.

COST OF THE OPERATION OF MOTOR CARS.—The expense of fuel, repairs, cleaning, etc., runs very uniformly, but with the expense per mile being so largely dependent upon the number of miles run per day, as well as on the wages paid the car crew, comparisons are very unsatisfactory. In actual service cars run, some months, as low as 10 and 11 cents a mile; whereas, cars in other localities will run as high as 16 and 18 cents a mile, and in one case, where a 100 horse-power motor car and trailer has replaced a steam locomotive and train (account of the limited mileage per day), the cost of operation runs as high as 20 cents a mile. On branch lines the motor car should make not less than 100 miles a day. The service of the gasoline motor car is unquestionably different from that of either electric or steam cars. To man the gasoline car with a steam train crew is exceedingly expensive and inadvisable, and does not produce proper results; to man the gasoline motor car with an electric car crew would be equally as unsatisfactory. A well-paid mechanical man to have entire charge and run the motor car, with an assistant to collect tickets, is the best and most economical arrangement possible.—*Mr. W. R. McKeen, Jr., at the New York Railroad Club, Apr., 1907.*

TEAM WORK.—I notice that Mr. Brazier is a man who believes in team work, no matter what department he belongs to. I think that we should teach our men that we have a department in name only. Of course, we look first to our own department, but it should, on the other hand, be a helper of the other departments, and as stated above, a department in name only. We have a great many departments on our railroads, but they all have the same treasurer, and we are all working together to hold the money in the treasury.—*Mr. N. M. Rice before the Railway Storekeepers' Association.*



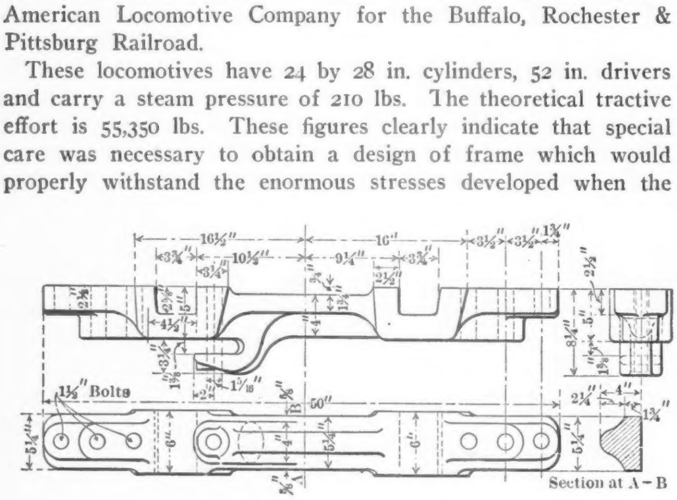
MAIN FRAMES—DECAPOD LOCOMOTIVE—BUFFALO, ROCHESTER AND PITTSBURG RAILROAD.

CAST STEEL FRAME, DECAPOD LOCOMOTIVE.

BUFFALO, ROCHESTER & PITTSBURG RAILROAD.

On page 123 of the April issue of this journal we illustrated, giving general and boiler drawings, a very large simple Decapod locomotive, an order of which is now being built by the American Locomotive Company for the Buffalo, Rochester & Pittsburg Railroad.

These locomotives have 24 by 28 in. cylinders, 52 in. drivers and carry a steam pressure of 210 lbs. The theoretical tractive effort is 55,350 lbs. These figures clearly indicate that special care was necessary to obtain a design of frame which would properly withstand the enormous stresses developed when the locomotive is working at full power, and we give in the accompanying illustration a detailed drawing of the cast steel frame and pedestal binders which are being applied to these locomotives.



PEDESTAL BINDER—DECAPOD LOCOMOTIVE.

It will be seen that while no attempt has been made to carry the I-beam section idea throughout the design, still the metal has been distributed with considerable care and that the T-section is approximated in many places, giving a depth of rail between pedestals of 7½ in., of which 4½ in. is the full width of the frame and 3 in. is narrowed down to 5¼ in. Furthermore the bottom rails between the first and second, and the second and third driving pedestals are made of different widths to accommodate the stresses at these points.

The main frames are of a single casting and measure 37 ft. 10 in. over all, being normally 6 in. wide. The section forming the front rail, which passes below the cylinders, is narrowed to 5 in. in width for most of its length, and is 9 in. deep. The cast steel bumper plate has arms extending inward which are fitted and fastened to this narrowed section of the main frame.

The top front rail is of wrought iron and connects to the main frames by six 1½ in. bolts and three keys, the connection extending over and back of the front driving pedestal.

The pedestal binders are of cast steel of a design clearly shown in the illustration and are arranged for adjustable wedges. They are fastened to the main frame by three 1¼ in. bolts on either end.

ELECTRIFICATION OF STEAM RAILROADS.

At the electrical night of the New York Railroad Club, a brief account of which was given in the previous issue of this journal, Mr. Geo. Gibbs, chief engineer of the Pennsylvania, New York and Long Island R. R., presented a brief paper covering the general proposition of the application of electricity to steam railroads, which, in view of the extravagant claims and prophecies lately being made, is of special interest as portraying a common sense view based on extensive experience and study of all features of the problem. Mr. Gibbs said:

"Among the manifold problems arising for solution in the application of electricity as a motive power for railways, the following appeal to me as especially worthy of our consideration at this time. They are:

Its proper field.

The character of the service to be aimed at.

Its cost.

"The sequence of electric railway development has been from light trolley-car service to heavy interurban; thence to service by trains on city traction systems, in which the speeds and weights approximate those on steam railway lines, and where frequency and volume of service exceed the latter even. Lastly, the application of the new motive power to certain portions of steam railway lines for tunnels, railway terminals and for mountain grade work."

The developments up to date have been logical and the advantages, as measured by the results, sufficient. They are:

1. Means of securing almost unlimited power for traction.
2. Convenient application and control of these means.
3. A motive power well adapted to use in streets and congested centers of population.
4. Increase in average speed for service with frequent stops.
5. Increase in capacity of the line.
6. Cleanliness and attractiveness to the public.
7. Encouragement of travel by reason of the above and of frequent service.
8. Economy of operation in a dense service.

The proposition now advanced is to apply electricity to general railway service. In considering this we should not allow the enthusiasm of the public and electrical engineers to obscure our just perception. Of the electric traction advantages above enumerated it is questionable if many apply to average trunk line service, and if they do in part apply, it is doubtful if the public will largely benefit, and it appears certain that the owners of the properties need not expect to gain greatly thereby.

Trunk line service is to-day conducted, irrespective of the character of the motive power by relatively infrequent and heavy train units, adapted as closely to the public needs as the length of haul, physical conditions, track, safety and reasonable cost of service permits. This may not be the popular belief, but it is a fact, and it is unsafe to assume that railway men are, as a rule, unintelligent and do not strive to supply what the public wants as far as the limitations permit. Electric traction would provide a new motive power, but unless it increases the capacity of the lines, builds up new business which does not now exist, or pays for its adoption by savings in cost, its use is neither logical nor probable.

The cost of inaugurating electric traction on a steam railway line has almost invariably been underestimated. Of its very high cost the public is absolutely ignorant, and to the few railway men who have had occasion to inquire into the matter the figures have appeared staggering and the reasons therefor incomprehensible. I shall not attempt, in this brief talk, to elucidate the matter further than to say that electric traction requires power plants of a capacity to take care of the peak load; the trains must be supplied with motive power, which displaces steam locomotives only and at a much higher cost than the latter; lastly, an expensive continuous contact system over the entire line to supply current from the power plants to the trains. These items foot up to a very heavy total cost per mile of road; but, in addition—and this is a point which is often ignored by estimators—is the fact that electric apparatus cannot be supplied to an existing steam railroad without many changes in its physical features and equipment. These changes amount in some cases to a virtual rebuilding of the line, and, according to my experience, the electric items making up the equipment of a steam railroad under average conditions are from one-half to two-thirds of the total cost only. Furthermore, it may not infrequently result that a steam railway wishing to electrify and to properly adapt its lines to secure the legitimate advantage of same will be found obliged to double its capitalization per mile; this is a contingency which can be complacently faced by few railways, and does not argue for early or wholesale conversion.

I have stated that trunk-line service is likely to continue to be conducted by rather infrequent and heavy train units, a system well adapted to the physical limitations of the property. It appears, therefore, that in adopting electricity at heavy cost we must secure operating savings at least sufficient to offset interest and depreciation charges on the added investment. What are the facts as to this? It has been proven that for a reasonably dense train movement (say suburban), the total cost, including general expense but not capital charges, per car mile of passenger movement will be less for electric than for steam power—for very dense movement substantially less. But in average trunk-line work, both freight and passenger, it will be found that in handling a given traffic electric operation cannot be made to effect nearly enough savings to justify its adoption on this ground; and in suburban service, which is the legitimate field for electric traction, it will require an extremely dense movement, approximately that of the New York Elevated Road and Subway, to effect operating savings sufficient to offset the added charges.

Will, therefore, the introduction of electricity on steam railways cease before it has fairly started? By no means. It will be applied, as Mr. Aspinall has remarked, to make money, not to save it. It will be used in certain large terminals, where reduction of switching will increase capacity, and where safety and cleanliness in tunnels and cities are controlling features, regardless of the great expense. It will be used for heavy mountain grade operation where cheap fuel or water power can be utilized, and powerful electric locomotives may enable the ruling train loads to be taken over the grade without doubling.

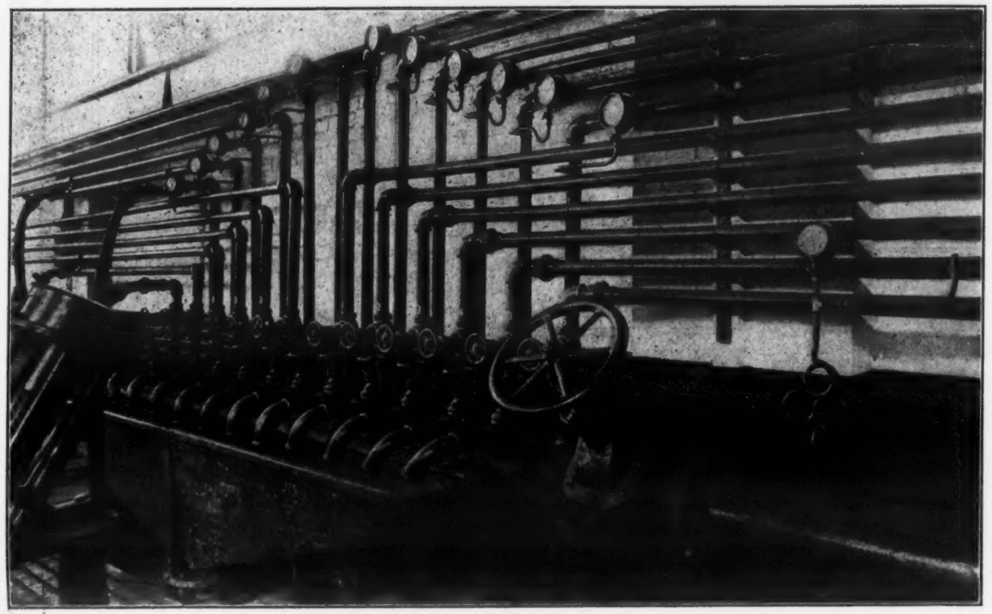
A word regarding character of service, and in this I have especially in mind the popular demand for high speed. Getting there quickly is a vice which is growing upon us. The steam railways are striving to satisfy the demand, and perhaps the statements of railway men as to having reached the limit of capacity in this regard is largely responsible for the rosy promises of electric promoters and the fond hopes of the public. It cannot be too clearly understood that high maximum speed is a function of safety, physical conditions of track, etc. Electric power cannot increase the maximum steam speeds except by altering these conditions. High sustained speed may, in some cases, be attained by electric power, as on a broken gradient and with excessive weights of train, where the possibilities of steam are exceeded, but only at high cost. High average speed in local service with frequent stops is a legitimate field for electric supremacy, and even here a word of caution is necessary.

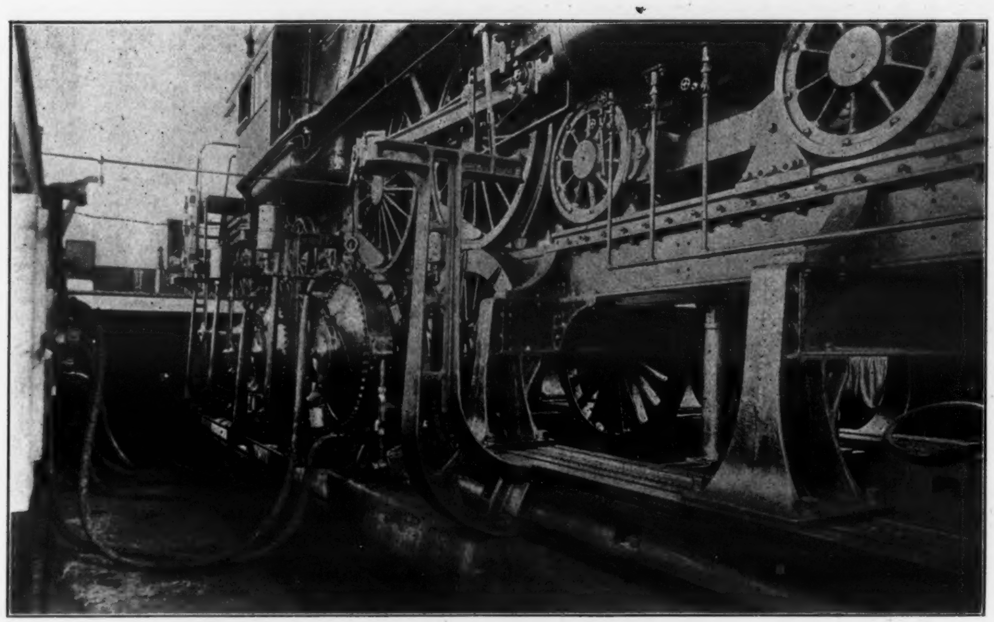
This high average speed is made possible in electric traction by equipping each car with motors, thus consolidating a large amount of power on the train. This means that the train can be accelerated from a stop with great rapidity and the average schedule shortened over the lower starting rates with steam locomotives. The higher the accelerating rate, however, the greater amount of energy consumed during the accelerating period and the higher equipment costs for motors, transmission line and power house, so that we soon arrive at a point where, by striving after speed, economy, reliability, and even safety is sacrificed. We also reach a point where the capacity of the line is affected by increase in speed (because the trains must be spaced farther apart to insure safety), and this means that fewer trains can be despatched over the same track in an hour.

There has been a tendency for the public to generalize on the advantages of electric traction from too few examples, and this tendency promises to work injustice and hardship to the railroads unless the growth of electric traction is guided along rational lines. It is certain that heavy electric traction work may be called in the tentative stage at present, and its development must be accomplished for some time to come at heavy cost to the pioneers. Its introduction, as in the case of the terminals in New York City, is sometimes a public and operating necessity, but these conditions do not obtain to like extent in smaller centers of population, and the cost of the introduction elsewhere for like purposes may be easily a crushing burden.

Summing up, if the statements above briefly advanced are well founded, it appears that electric traction has solved the city and suburban transportation problem for rapid, convenient and safe movement of a dense traffic; it has been found adaptable to the special conditions of terminal, tunnel and heavy grade work. It has not yet proven its advisability for the movement under trunk-line conditions of long distance heavy train units at infrequent intervals, because of its very high first cost, and because of the lack of stability in methods and appliances for economically and reliably conducting the service. In my opinion the time is far distant when we are ready to discard, even to an appreciable extent, the time-tried steam locomotive in this service; and when the time does come, it will be through a radical change in methods from any of those heretofore advanced.

STANDARD LOCOMOTIVES REDUCE OPERATING COSTS.—In the early eighties, Mr. N. W. Sample was superintendent of motive power of the Denver & Rio Grande Railroad, then narrow gauge. Under his direction the road used but three classes of locomotives, passenger, freight and switching. The parts of the switching locomotives were largely interchangeable with those of the passenger and freight, and the tenders of all were alike. Mr. Sample purchased cylinders, frames and rods from the Baldwin Locomotive Works and kept his rolling stock continuously in service, reducing the cost of operation, including wages, fuel, repairs and all supplies to sixteen cents per train mile. When the road was changed to standard gauge (1882-1887) the cost of operation only increased to eighteen cents per train mile.—*Arthur L. Church in "Record of Recent Construction," No. 60.*



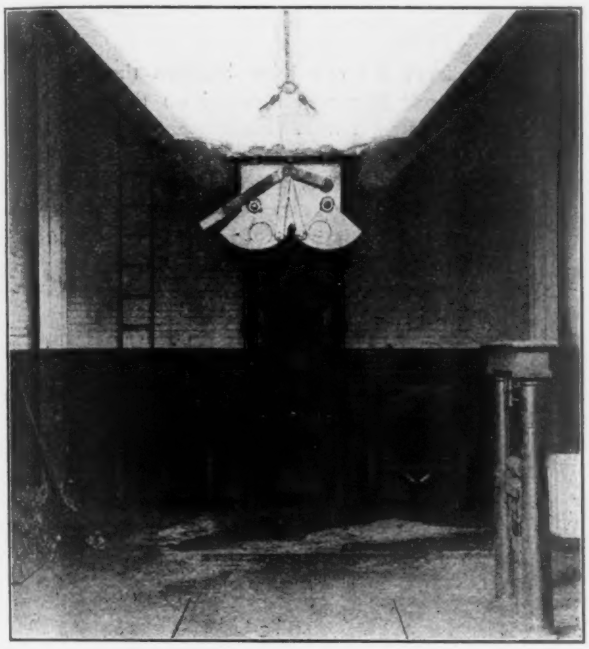


PENNSYLVANIA RAILROAD LOCOMOTIVE TESTING PLANT AS INSTALLED IN ITS PERMANENT QUARTERS AT ALTOONA, PA.

LOCOMOTIVE TESTING PLANT.

PENNSYLVANIA RAILROAD.

The locomotive testing plant, on which so large an amount of valuable data was obtained at the St. Louis Exposition, is, as was mentioned in our February issue, now in operation at Altoona. The plant is housed in a steel and brick building, specially constructed for the purpose, an exterior view of which



BOTTOM OF COAL SUPPLY BIN.

is shown in one of the illustrations. Advantage has been taken of the experience gained from the operation at St. Louis and a few minor changes have been made in the installation at Altoona, with the result that the plant now operates without any of the difficulties which caused so much delay and trouble during the former tests.

The construction of the testing plant, its dynamometer and other apparatus, was illustrated and described in detail in the April, 1905, issue of this journal, page 127. There have been practically no changes made in the apparatus described at that time and reference can be made to that article for the general features and details of the plant.

The accompanying illustrations show several views of the present arrangement and it will be seen that ample provision has been made for good light, ventilation, convenient location of instruments, special facilities for handling and weighing coal and ashes, protection of the recording mechanism from any disturbing conditions, etc.

It will be remembered that one of the most troublesome features of the operation at St. Louis was the difficulty in obtaining a supply of water for the friction brakes at a constant pressure. In the present installation this difficulty has been entirely removed by the use of a two-stage centrifugal pump driven by a 75 h.p. electric motor, which is fitted with an automatic control and delivers water at a constant pressure of 75 lbs. to the main header, from which the branch pipes for the individual brakes are led. The pump draws its supply from one of the large water tanks nearby, the temperature of which is sufficiently low for this purpose. The discharge from the brakes empties into an iron trough, which is shown in one of the illustrations. From this it runs by gravity into a tank located beneath the floor of the building, from which it is again forced back into the outside tank by another centrifugal pump driven by a 20 h.p. electric motor. This apparatus is capable of delivering a large volume of water at low pressure, which is needed for high speed tests, and it has a capacity of 900 gallons per minute. The automatic features for maintaining a constant pressure have proved to be a success and there has been no difficulty with sudden fluctuations of water pressure.

The dynamometer has been placed somewhat farther away from the locomotive than was the case at St. Louis, thus allowing more room for the firing platform. It has also been enclosed in a small steel and concrete housing, which protects it from the dust and dirt occasioned by the handling of coal and ashes in the immediate vicinity.

For handling the coal for the locomotive a very complete plant has been installed. The loaded coal cars are run in on the track alongside the building and dumped into a hopper below the track level. From this hopper the coal is carried by a bucket conveyor to two elevated reinforced concrete pockets, each of which has a capacity of 50 tons. These pockets are located over the larger of the two rooms directly back of the testing laboratory and each is provided with a bottom cut-off gate, of a type shown in one of the illustrations. The coal is discharged from the bins into wagons holding 1,000 lbs. each, which are run over the weighing scales and then pushed along a passage way beneath the laboratory floor to a hydraulic elevator, which raises them to the firing platform, where the cars are dumped. The ashes are discharged from the locomotive into the bottom of the pit, from which they are shoveled into a wagon and after being weighed are raised in the hydraulic elevator to the level of the main floor and emptied into a chute leading to a conveyor, which delivers them to an ash bin on the outside track. From this they can be discharged into cars and hauled away.

The water for boiler use is taken from a supply tank in the corner of the laboratory, which is filled from one of the large outside tanks, the water being passed through the weighing tanks, from which it is discharged into the supply tank. It also passes through a meter on its way to the injector, the reading of which is used as a check upon the weighing tanks. The overflow from the injectors is collected and returned to the supply tanks by a small motor driven centrifugal pump.

The spark collecting apparatus has been greatly improved over the one originally used in St. Louis, and after much experimenting an arrangement has been devised which collects as large a proportion of the sparks as it is possible to get without seriously obstructing the draft. This entire apparatus is carried from a truck supported on run-ways above the roof of the building and is adjustable over a distance of 16 ft. 6 in. The opening in the roof is protected by a hood, which keeps it closed to the weather at all times.

The smaller of the two rooms located back of the laboratory proper is arranged for the computers and here the tests are worked up as soon as completed.

Some changes have been made in the foundations of the plant, which provides better drainage than it was possible to obtain at St. Louis. The system of piping has also been more carefully worked out and arranged, but in other respects the plant remains practically as originally built.

Tests have been completed on a Pennsylvania simple Atlantic type locomotive, and it is stated that the plant is at present turned over to the United States government for use in connection with the testing of briquettes as locomotive fuel.

COST OF LOCOMOTIVES.—The following table gives the weights and prices of locomotives in 1885 and 1905. As the only available weight in many cases is with the locomotive in working order, the price per pound is figured from the total weight of the engine with three gauges of water in the boiler, but excluding the tender.

WEIGHTS AND PRICES OF LOCOMOTIVES 1885 AND 1905.

1885.	Weights.	Price.	Price per lb.
American Type	80,857	$6,695	$0.0828
Mogul Type	72,800	6,662	.0912
Ten Wheel Type	85,000	7,583	.0892
Consolidation Type	92,400	7,888	.0854
1905.	**Weights.**	**Price.**	**Price per lb.**
American Type	102,000	$9,410	$0.092
Atlantic Type	187,200	15,750	.083
Pacific Type	227,000	15,830	.070
Ten Wheel Type	156,000	13,690	.088
Consolidation Type	192,460	14,500	.075

—William Penn Evans before the Pacific Coast Railway Club.

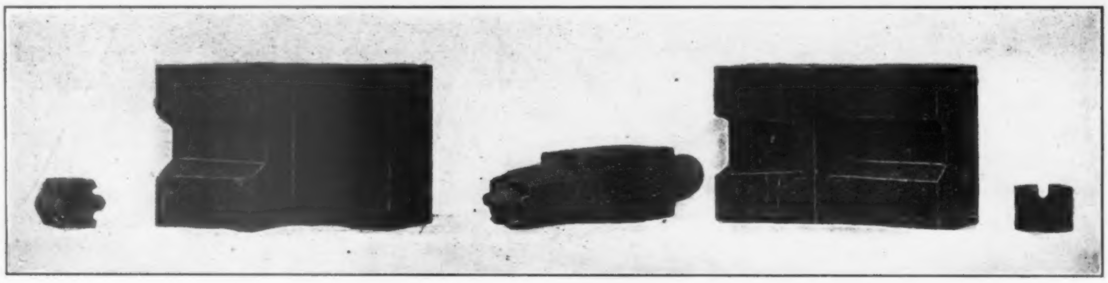


FIG. I. DIES AND HEADER FOR MAKING BRILL NUTS.

FORGING AT THE COLLINWOOD SHOPS.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

In April and June of last year, on pages 142 and 235, articles were presented on forging at the Collinwood shops. Since these articles appeared several new dies and headers have been made for use in connection with the Ajax forging machines, which are of interest. Ferguson oil furnaces are used for heating the iron.

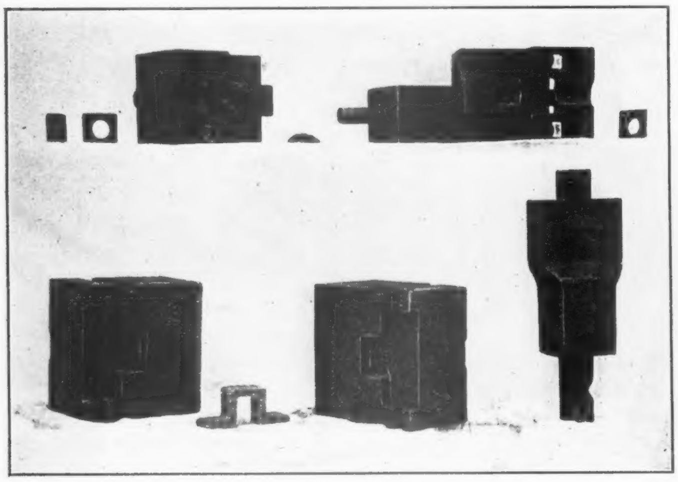


FIG. 2. DIES AND HEADERS FOR MAKING WASHERS AND A SIMPLE FORM OF BUCKLE.

One of the most interesting of these is a set of dies and header used on the 3½-in. Ajax machine for making a lock nut, which is used very extensively on the Lake Shore and is shown in the accompanying illustration. This nut is made in one operation. As the two dies move toward each other and close up a piece is sheared off the end of the hot bar and the header or plunger closes in forming the nut as shown and indenting it in the center to guide the drill. When the nut leaves the forging machine it is only necessary to grind off the thin fins and drill and tap it. As the nuts may be made practically as fast as it is possible to heat and feed the bar into the machine their cost is very low.

The second illustration shows two sets of dies and headers. The upper ones are for forming and punching washers which are used on passenger cars for tie and brace rods. This washer, as may be seen from the one lying between the die and the header, is flat on one side and rounded on the other. It is made from ½ x 1¾-in. flat iron. Each half of the die is made in two parts. The sliding part, which shears the bar, is guided by a pin and by two screw bolts which work in slots. One-half of the die is shown with the shear open and the other half with it closed. The heated bar is put in from the top and the two halves close together, gripping the iron. When the ram or plunger strikes, both of the shears are forced back, shearing the piece of iron, rounding it and punching the hole all in one operation.

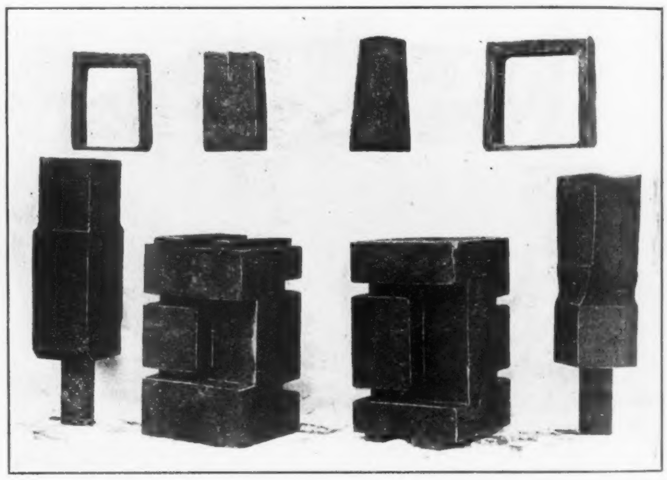


FIG. 3. DIES AND HEADERS FOR FORGING SPRING BANDS.

In the lower half of the photograph are shown the dies and header for making a simple form of buckle. The stock is placed in position, the two dies come together, grip the stock and the plunger bends and shears the metal in one operation.

Tools for forging spring bands are shown in Fig. 3. These bands are made from 4 x ⅝-in. merchant bar iron. The spring band is first bent so as to lap the iron at the heavy portion of the band. The piece is then heated to a welding heat and is placed between the dies and completed at one stroke of the ram.

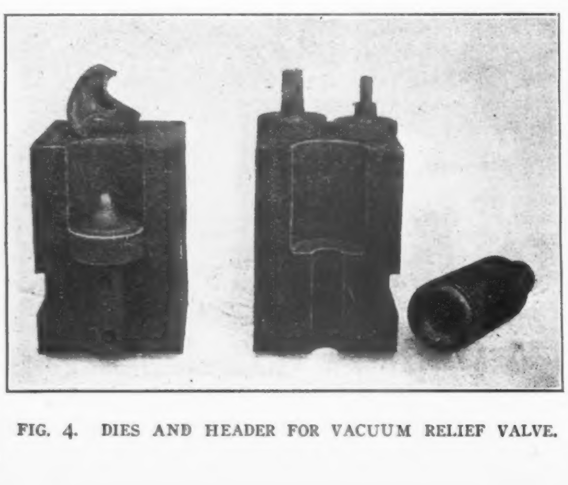


FIG. 4. DIES AND HEADER FOR VACUUM RELIEF VALVE.

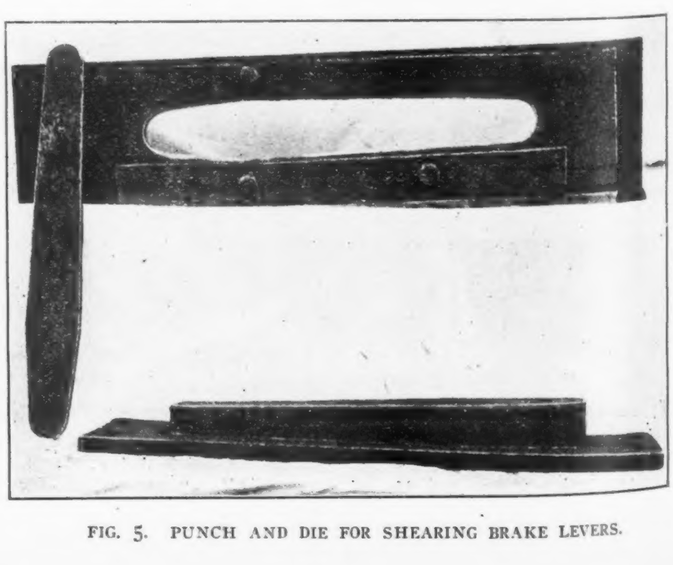
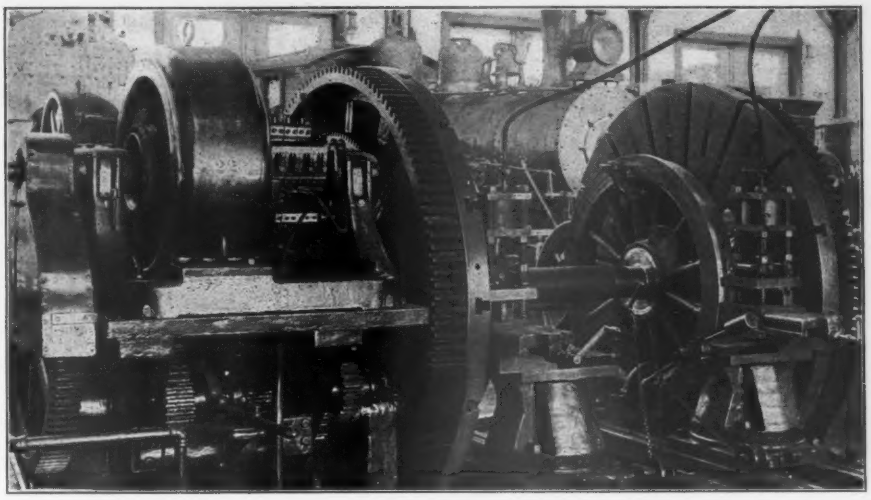


FIG. 5. PUNCH AND DIE FOR SHEARING BRAKE LEVERS.

The vacuum relief valve shown in Fig. 4 is made from 1-in. steel bar in two operations. The valve is first headed similar to a round head pin and the stock is sheared off to the desired length. It is then heated and at one stroke of the machine is completed by means of the dies and header shown in the illustration. The valve is half a pound lighter than the standard brass valve used for this purpose.

A punch and die for shearing brake levers are shown in Fig. 5. These tools have been used on one of the large bulldozers for a considerable time. They are made of cast iron and faced with steel plates. Commercial bar iron is ordered of the proper length for the levers and of a width equal to the widest part. The lever is formed with one stroke of the machine with only a small waste of material.

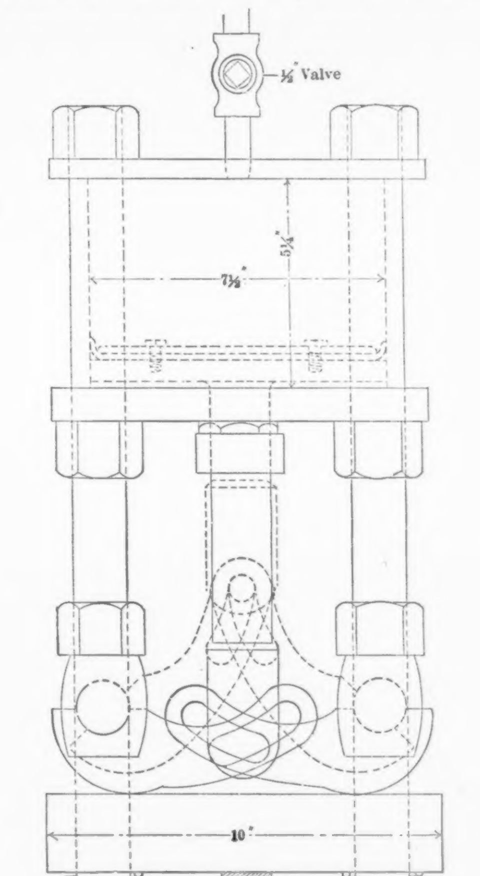


PNEUMATIC TOOL HOLDER ON DRIVING WHEEL LATHE.

PNEUMATIC TOOL HOLDER FOR WHEEL LATHE.

The accompanying illustrations show a pneumatic attachment for holding the cutting tools on a driving wheel lathe, which is giving very satisfactory service in the Grand Rapids shops of the Pere Marquette Railway.

This attachment was designed by Mr. F. C. Pickard, machine foreman of the shops, and by its use the time of changing tools in the lathe has been reduced from an average of five minutes to one minute and in addition all difficulty with broken studs, slipping wrenches, etc., has been eliminated. When it is considered that ordinarily the tools are changed five or six times while turning one pair of tires, it can be seen that the time saved by the use of this device is considerable.



PNEUMATIC TOOL HOLDER.

The construction is clearly shown in the illustrations. The air cylinder, which is connected to the carriage by four long stud bolts, is 7½ in. diameter and has a stroke of 5¼ in. The piston rod connects to two cam levers which force the tool holder plate down onto the tool, against the resistance of the four springs. The tool is in a holder consisting of a bar of steel 3 x 2½ in. and of the proper length, which is slotted to take a 1¼-in. square tool. The tool projects above the holder about ¼ inch and the tool plate bears directly on its top surface. When the air is released the tool plate is forced up ½ inch, giving ample room to remove or adjust the tool.

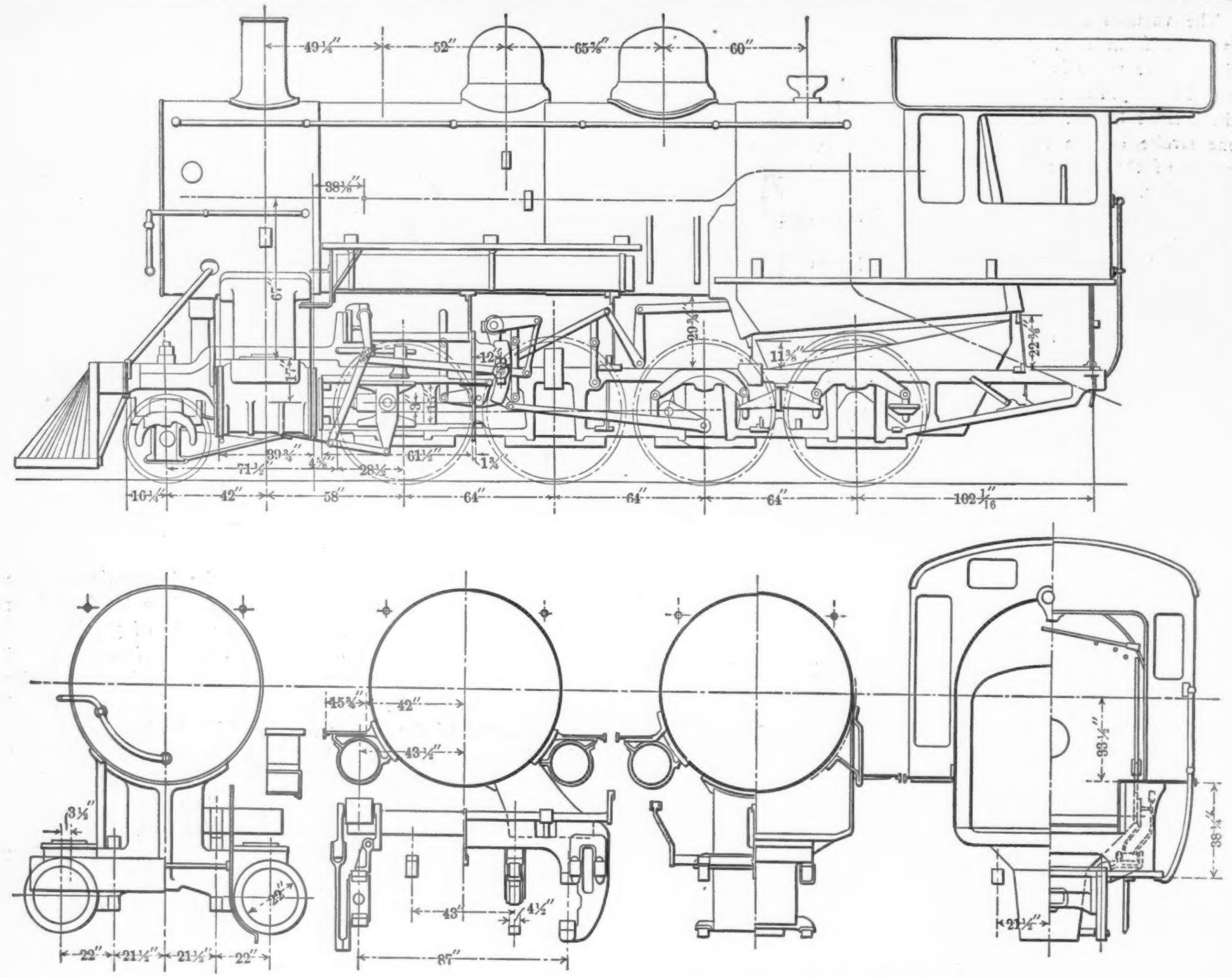
We are indebted to Mr. W. J. Haynen, former superintendent of shops at Grand Rapids, for the illustrations and description.

DEDICATION OF THE ENGINEERING SOCIETIES BUILDING.

The building of the Engineering Societies, at 29 W. 39th street, New York, was dedicated with appropriate exercises, beginning Tuesday, April 16. Mr. Andrew Carnegie, whose gift of $1,500,000 made possible this building and the structure of the Engineers' Club adjoining it on 40th street, was present and made a short address. The other speakers at the first meeting were Mr. Charles F. Scott, president of the A. I. E. E., and the chairman of the building committee; Mr. E. E. Alcott, president of the United Engineering Society, which is a holding organization of the building, and Dr. Arthur T. Hadley, president of Yale University. On the evening of April 16 a joint reception was held, the receiving parties consisting of the presidents of the three founder societies, at which time the entire building was thrown open for inspection. The following day the exercises were continued, consisting of addresses by the presidents of the three founder societies and presentation of medals for distinguished service to Ralph W. Pope, Frederick R. Hutton, and Rossiter W. Raymond, secretaries and past secretary of the several societies. The John Fritz gold medal was presented to Alexander Graham Bell at this meeting. Dr. James Douglas, past president of the Institute of Mining Engineers, also delivered an oration on the subject of "Ethics of Secret Processes in the Arts." Professional sessions of the founder societies were also held during the same week.

RESULTS OF PROPER SHOP MANAGEMENT.—In one of the shops of the Northwest where a proper system of shop management has been in conscientious operation for four or five years, the time of general repairs has been reduced from one month to thirteen days.—*William Penn Evans before the Pacific Coast Railway Club.*

The power efficiency of certain soft coals when used in the gas-producer plant is two and one-half times greater than when used in an ordinary steam-boiler plant.



ELEVATIONS AND SECTIONS, CONSOLIDATION LOCOMOTIVE—C. S., N. O. & P. R. R.

SIMPLE CONSOLIDATION LOCOMOTIVE.

COLORADO SOUTHERN, NEW ORLEANS & PACIFIC RAILROAD.

The Baldwin Locomotive Works are delivering an order of 26 consolidation locomotives to the Colorado Southern, New Orleans & Pacific Railroad, which are an excellent representation of recent practice in heavy single expansion freight engines. The design includes a large straight boiler 78 in. in diameter with 22 x 30 in. cylinders, having balanced slide valves actuated by the Walschaert type of valve gear. The driving wheels are 57 in. in diameter and the tractive effort is 43,300 lbs. The locomotives are estimated to weigh 182,000 lbs. on drivers and 207,000 lbs. total. This gives a factor of adhesion of 4.2, which is about the average figure for this class of locomotive.

These locomotives are very similar to the common standard consolidation locomotives of the Harriman Lines,* differing from them, however, in having slide instead of piston valves and in having a 78 in. in place of an 80 in. boiler. The heating surface is also much less, due to the smaller number of tubes, which are also but 14 ft. 6½ in. in length instead of 15 ft. In other respects, however, the two designs are very much alike except for the valve gear.

The boiler, as mentioned above, is of the straight type with a sloping throat sheet and back head. The mud ring is inclined toward the front and is supported on buckle plates bolted to frame cross ties. It is of cast steel and measures 5 in. in width all around. The barrel contains 386 2 in. flues, which give a heating surface of 2,939 sq. ft. The firebox contains 183 sq. ft. of heating surface, being 5.85 per cent. of the total heating surface. The grate area of 51 sq. ft. gives 1 sq. ft. of surface to every 61 sq. ft. of total heating surface, a figure which indicates that with an average grade of bituminous coal no difficulty should be found in obtaining sufficient steam without forcing the fire to an uneconomical rate of combustion.

The frames are of cast steel and measure 4½ in. in width. They have double front rails spanning the cylinders.

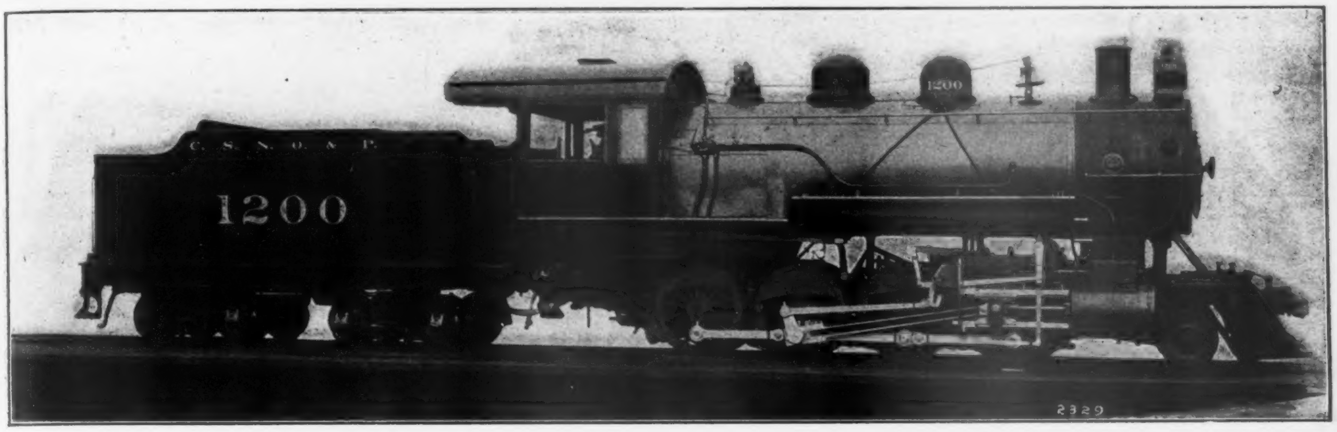
The general features of the design of Walschaert valve gear applied to these locomotives are quite clearly shown in the illustrations. The use of slide valves necessitates the transferring of the motion from the plane of the valve gear, which is outside of the guides, to a point 3½ in. inside the cylinder center, and this has been accomplished by the use of a rocker arm supported in bearings forming part of the frame cross tie, which is bolted to lugs cast in one piece to the upper front frame rail. This rocker shaft has two downwardly extending arms, the outer one being connected to a combination lever and the inner one by a cross head connection to the valve stem, which is supported and guided by a bearing resting on the top guide bar. Two reverse shafts are required in the design, the forward one being supported in bearings bolted to the guide yoke and the other one, which connects to the reverse lever, resting on the frame. It will be noticed that the eccentric rod connects to the link at a point which gives a shorter leverage than has been common in previous designs, and hence requires less eccentricity in the return crank for the same valve movement. It will also be noticed that there is a brace between the front cross tie and the guide yoke, which will be of material assistance in stiffening both, and in keeping the valve gear in better adjustment.

The general dimensions, weights, and ratios of these locomotives are as follows:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal

* See AMERICAN ENGINEER, 1905, pages 154, 200, 250, 288, 320, 353 and 441.



CONSOLIDATION LOCOMOTIVE—COLORADO SOUTHERN, NEW ORLEANS AND PACIFIC RAILROAD.

Tractive effort	43,300 lbs.
Weight in working order, est	207,000 lbs.
Weight on drivers, est	182,000 lbs.
Weight on leading truck, est	25,000 lbs.
Weight of engine and tender in working order, est	355,000 lbs.
Wheel base, driving	16 ft. 0 in.
Wheel base, total	24 ft. 4 in.
Wheel base, engine and tender	56 ft. 3 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.20
Total weight ÷ tractive effort	4.76
Tractive effort × diam. drivers ÷ heating surface	790.00
Total heating service ÷ grate area	61.00
Firebox heating surface ÷ total heating surface, per cent	5.85
Weight on drivers ÷ total heating surface	58.20
Total weight ÷ total heating surface	66.00
Volume both cylinders, cu. ft	13.20
Total heating surface ÷ vol. cylinders	236.50
Grate area ÷ vol. cylinders	3.87
CYLINDERS.	
Kind	Simple
Diameter and stroke	22" × 30"
Kind of valves	Bal. Slide
Type of valve gear	Walschaert
WHEELS.	
Driving, diameter over tires	57 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10 × 12 in.
Driving journals, others, diameter and length	9 × 12 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	5½ × 10 in.
BOILER.	
Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	78 in.
Firebox, length and width	108 × 68 in.
Firebox plates, thickness, side	5/16 in.
Firebox plates, thickness, back	⅜ in.
Firebox plates, thickness, crown	7/16 in.
Firebox plates, thickness, tube	½ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	386—2 in.
Tubes, length	14 ft. 6½ in.
Heating surface, tubes	2,939 sq. ft.
Heating surface, firebox	183 sq. ft.
Heating surface, total	3,122 sq. ft.
Grate area	51 sq. ft.
Center of boiler above rail	115½ in.
TENDER.	
Frame	Steel Channels
Wheels, diameter	33 in.
Journals, diameter and length	5½ × 10 in.
Water capacity	7,500 gals.
Coal capacity	12 tons

WATER PURIFICATION.

The report of the Committee on Water Service, which was presented at the last convention of the American Railway Engineering and Maintenance of Way Association, contains a formula for determining the point at which it will pay to treat foaming water. This section of the report is as follows:

If natural water containing 10 grains of foaming solids has this quantity raised to 20 grains by using soda ash as a reagent, there would be a minimum of 20 per cent. water wasted to keep it below the critical point, while only 10 per cent. would be wasted if treated with barium hydrate. Therefore, the grains increase per gallon of sodium sulphate caused by using soda ash as a reagent represents the minimum per cent. of water wasted in changing boiler water over what would be wasted if water was not softened, or if barium hydrate was used as a reagent. The minimum waste would be represented by the total cost of pumping and treating this wasted water by soda ash plus the cost of the fuel required to raise this water from the temperature of feed water to the temperature of the water in the boiler.

For an increase of one pound foaming matter per thousand gallons of feed water, it would be the total cost of pumping and treating 70 gallons of water, and the fuel for heating it to temperature of boiler water. For any other increase per thousand gallons of water, the minimum cost would be directly proportional to this.

The following equation is given to show the point where the benefits derived from treating the water will just balance the cost of treating:

X = Number of hundredweight (100 pounds) of solids removed from water per annum.
B = Money value of benefits received from removing 100 pounds of solids. This will include:
Saving in boiler washing and repairs.
Saving in fuel.
Increased service received from locomotives, represented by the interest on the cost of additional number of locomotives that would be required to perform the service rendered by locomotives using the soft water, if based on the performance prior to treating the water.
C = Cost per 100 pounds of solids removed to operate the plant, as follows:
Additional cost of labor.
Additional cost of fuel and power.
Cost of chemicals.
Cost of current repairs.
D = Cost of plant installed.
I = Interest per annum on D.
L = Estimated useful life of plant in years.
R = Estimated value of materials recovered from plant after L years.
S = Annual depreciation of plant, equivalent to a sum per year, which, if placed in a sinking fund at I rate of interest, would amount to D — R in L years. (See table, page 16, Kent's pocket book.)

The benefits would just balance the cost when

$$X B = X C + I + S.$$
$$X = (I + S) \div (B - C).$$

The number of pounds solids removed daily to make benefits just equal the cost would be

$$\frac{I + S}{3.65\,(B - C)}$$

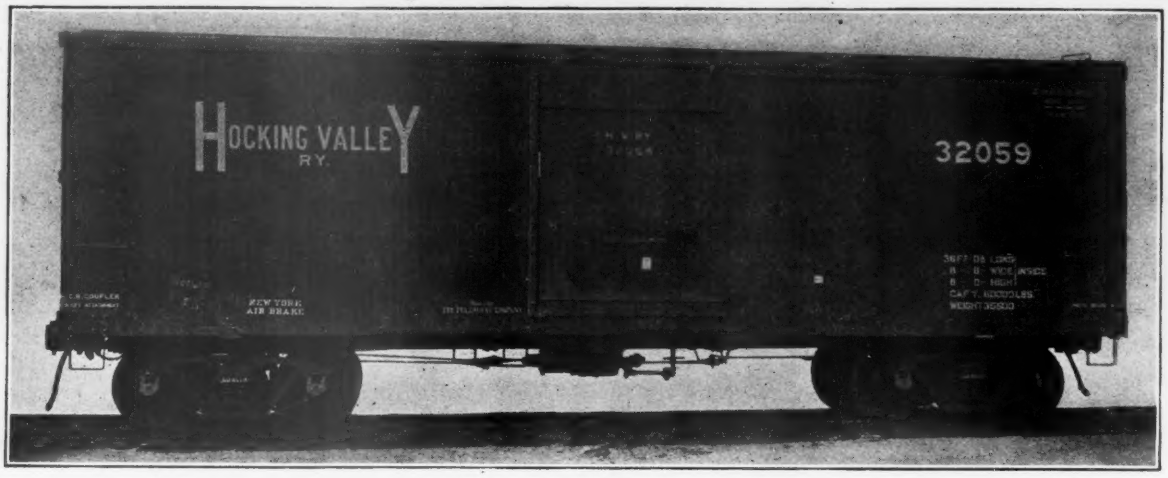
If more than this amount of solids is removed the plant will be profitable to the company.

Values for B can only be fixed for each particular case, as some of the matter held in solution is much more injurious than the same weight of other matters. The mechanical department of each railway should be able to approximate the values, knowing the proportions of the injurious matter in the water.

MEETING OF THE AIR BRAKE ASSOCIATION.—The fourteenth annual convention of this association will be held in Columbus, Ohio, beginning Tuesday, May 14, 1907. The convention headquarters will be at the Great Southern Hotel. This date is one month later than the regular meeting and it is believed that it will be a better time for holding the convention than in April.

MEETING OF THE ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS.—Upon the urgent request of a considerable number of members of the Association of Transportation and Car Accounting Officers, the executive committee has favorably considered the question of changing the date of the annual meeting, so that this assembly will be held in St. Paul, Minn., Tuesday and Wednesday, June 25th and 26th.

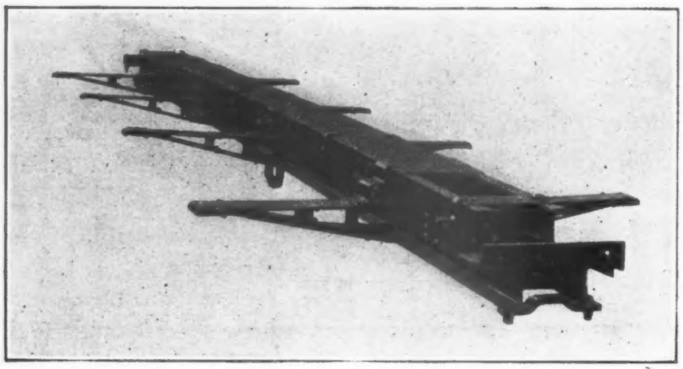
If "subscriber" of Baltimore will send in his name and address we will be glad to furnish him the information requested.



BOX CAR WITH RALSTON STEEL UNDERFRAME.

STEEL UNDERFRAME FOR FREIGHT CARS.

A very urgent and general demand for freight car equipment, during the past few years, with the resulting congestion of orders at the car building companies and their inability to give early deliveries, has led many of the railroad companies to build as large a part of the new freight equipment as possible at their own shops. While most railroad car shops are in a position to construct wooden freight equipment, comparatively few of them are able to turn out steel, or composite cars, with reasonable economy or rapidity. In the present state of affairs, in which so large a proportion of the cars in service are of all steel, or equipped with a steel underframe, it is almost necessary to have at least a steel underframe, in freight cars, in order to get a reasonable length of service out of them.



RALSTON STEEL UNDERFRAME.

Recognizing these conditions the Ralston Steel Car Company has designed a type of steel underframe, which it is prepared to furnish complete to suit the specifications of the road, and on which the railroad shops can easily erect a wooden superstructure, giving a composite car capable of standing rough usage and at the same time permitting the railroads to build cars in their own shops, and thus obtain quick delivery.

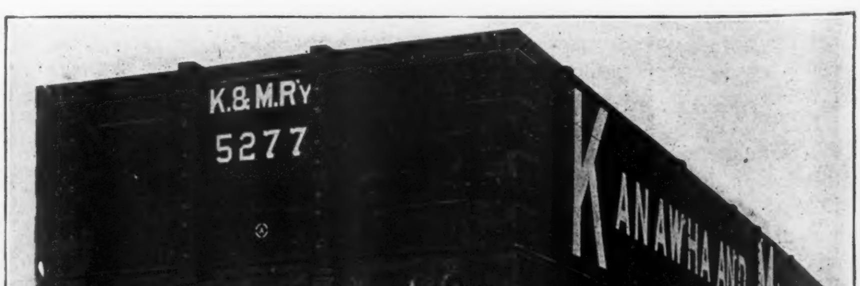
This underframe is shown in the accompanying illustrations and is designed to have its greatest strength in that part of the car where it is most needed for taking care of shocks due to rough handling, as well as for supporting the rated capacity of the car. The center sill is a heavy box girder built up of channels with top and bottom cover plates extending continuous between the bolsters. The bolsters and needle beams are built up with the one-piece tension members passing through the webs of the channels and the compression members passing below the center sill. Filling pieces are provided between the two members, securing them to the center sills and to each other. These filling pieces are malleable iron castings. The channel center sills are continuous from end sill to end sill and are notched and bent over at the end, forming a pocket and support for the wooden end sill. This point is further reinforced by the addition of a buffer angle riveted to the underframe and bolted to the end sill.

This type of underframe is also furnished as a repair feature and is supplied to railroad companies for application to cars requiring heavy repairs. Slight changes are made in the design for such conditions and it is usually to fit the regular body bolster, if that is of metal, to the new underframe. An example of the underframe, as thus used for general repairs, is shown in the illustration of the Kanawha & Michigan Railway gondola car.

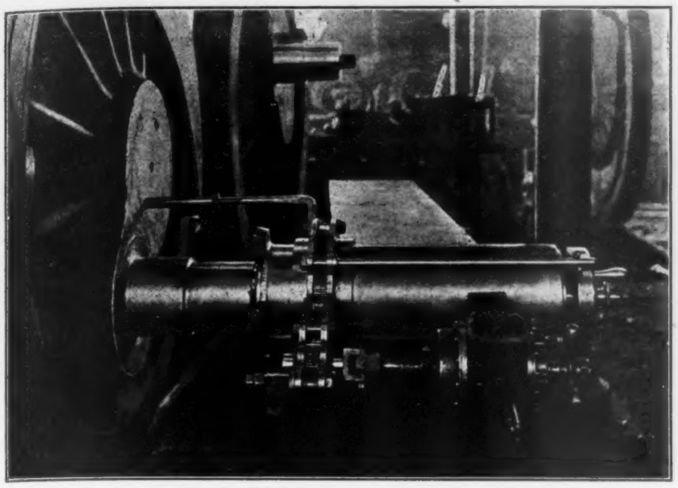
The Ralston Steel Car Company is now completing an order of 1,500 underframes for the Pullman Company, a large part of which are being applied to some 60,000 lb. capacity box cars for the Hocking Valley Railway. An example of these cars is also shown in one of the illustrations.

ECONOMICAL TONNAGE.—It must be borne in mind that the most economical tonnage for a locomotive is not always its maximum tonnage. For any given division there is a certain combination of speed and tonnage for each class of engine used that will give the most economical results. When this combination has been determined any further saving must come from the introduction of heavier power.—*William Penn Evans before the Pacific Coast Railway Club.*

SELF-CLEARING COAL CARS PROFITABLE.—Self-clearing cars can be unloaded into a hopper for at least six cents a ton less than the cost of unloading flat bottom cars by hand. Using 15 per cent. per annum of the original cost as the cost of the plant, an expense of $146 is justified to save handling one ton a day by hand.—*Report of Committee, Amer. Ry. Eng. & M. of W. Assoc.*



RALSTON STEEL UNDERFRAME AS A REPAIR FEATURE.



PORTABLE CRANK PIN TURNING MACHINE ASSEMBLED.

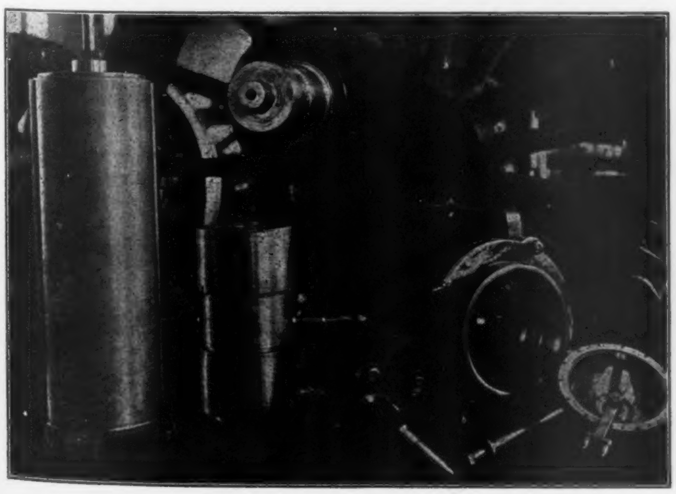
PORTABLE CRANK PIN TURNING MACHINE.

There has been in use for some time past on the Grand Trunk Railway several portable machines for turning crank pins, which were designed by Mr. M. H. Westbrook, machine shop foreman, at the Port Huron shops. These machines have proved to be most successful in every way and not only save a large amount of time and money in truing up crank pins which absolutely require attention, but also have been found to be so convenient that the pins are maintained in much better general condition since the machine is as readily available for use in the roundhouse as in the shop.

The accompanying illustrations show the machine as assembled and also the various parts. It will be noticed that it consists of comparatively few pieces, all of which are light in weight, permitting the machine to easily be put up by one man or his helper.

It is fair to assume that the crank pin stud and the outer end face of the pin will always maintain their shape and size, and hence a machine which operates from an adjustment taken at this point will bring the pin when turned, with its faces parallel to the original face and in exact quarter. This machine operates on this principle and hence should turn out perfectly satisfactory work.

The center bearing of the machine, which is shown with two handles attached in one of the illustrations, is screwed on the end of the crank pin stud by means of these handles until it takes a bearing against the face. The handles are then removed



PORTABLE CRANK PIN TURNING MACHINE DISMANTLED.

and the sleeve shown at the left hand is slipped over the barrel on which it has a bearing. Attached to the inner end of this sleeve are four lugs for carrying the tools for roughing, finishing and filleting the crank pin. These tools are of ⅝ in. round, high speed steel. The gear wheel and casing are then slipped over the two feather keys on the sleeve and the air motor is connected.

The feed of the sleeve is accomplished through a mechanism contained in a hand wheel attached to the outer end of the sleeve, which works on a feed spindle fastened to the stationary center bearing. The feed can be either automatic or by hand, as desired, it being possible to change from one to the other without stopping the motor. Provision has been made for taking up any lost motion, due to ordinary wear and tear, between the barrel and the sleeve, by adjustable rings, which are screwed against taper split bushings on either end.

REMARKABLE COUPLER CASTING.

The accompanying illustration shows a bottom lug broken from a coupler while in service on the Mexican Central Railway. This proved to be a most remarkable freak casting and consisted simply of a shell of steel ⅛ in. thick, which gave no evidence from the exterior of any defect. Although there are a large number of couplers of the same make in service on that

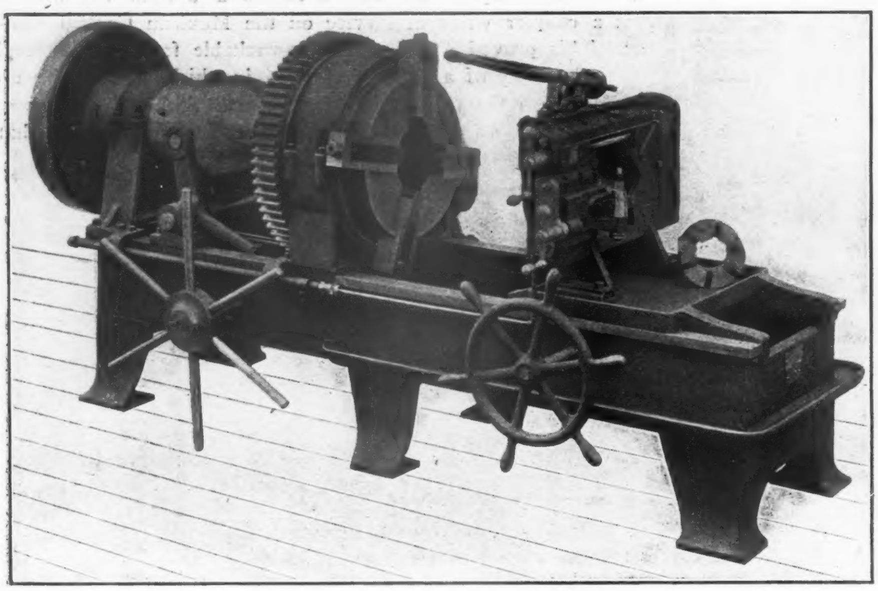
road, none of the others have been found to be defective in this manner, and it is no doubt one of those unexplainable occurrences which occasionally are found in castings of all kinds.

MOTOR CARS FOR BRANCH LINES.—Branch lines collect freight traffic and feed the main line, and the limited passenger business, of course, can be handled economically when turned over to the main line. Thus it is, if the steam train could be replaced by a combination motor car, a great saving could be made in the operating expenses. Passenger traffic which would be insufficient to fill a steam train in most cases would justify the operation of a gasoline motor car. Frequency of service could be given the public, which, of course, is much appreciated. The number of trips, cost of operation, etc., is entirely dependent upon the density of traffic and the length of the branch line. On steam railroads in direct competition with the frequent service of electric lines, a motor car of higher power is necessary to obtain the rapid acceleration and high speed required for this class of service. However, with these high-power engines there seems to be no particular increase in the cost of operation, as larger engines work more economically per horse-power developed than the the smaller ones. These cars are an entirely new style of transportation medium, and should be constructed, not along the conventional lines of an electric car, a steam passenger coach or railroad locomotive, but should be designed on entirely new lines; in other words, on lines particularly adapted for this new class of service.—*Mr. W. R. McKeen, Jr., before the New York Railroad Club.*

DIFFERENT LOCOMOTIVE DESIGNS.—There are in existence at the Baldwin Locomotive Works something like 4,900 designs of cylinders, 2,000 of driving boxes, 10,000 of springs, 3,800 of rods and 7,300 of boilers, to all of which new designs are being added daily. The list might be extended indefinitely.—*Arthur L. Church in "Record of Recent Construction," No. 60.*

A NEW PIPE THREADING AND CUTTING MACHINE.

A new size of pipe threading and cutting off machine, known as the P. D. Q. C. No. 6, has recently been brought out by the Bignall & Keeler Mfg. Co., Edwardsville, Ill. The machine is particularly adapted for shops having large quantities of pipe of one size to thread at one time. It is equipped with a quick operating chuck, controlled by a hand wheel and pinion which engages in a segment gear on the end of the cone shifting arm. The cone slides freely on the arbor; as it is moved forward rollers on the ends of the chuck jaw arms roll up on the surface of the cone, and the arms being thereby spread apart tighten the jaws on the pipe. The gripping chuck can be operated while the machine is running and the jaws being once set for a given size of pipe, an entire lot can be threaded without stopping the machine. The steel jaws in the chuck are graduated, which facilitates the setting for a given size of pipe.



BIGNALL & KEELER NEW PIPE THREADING AND CUTTING MACHINE.

The die head is of the Peerless type, as used on the machines of similar type manufactured by this company, in which the dies can be instantly released from the pipe after the pipe is threaded. The cutting-off tool is held in the slide on the front of the die stand and a reaming tool for removing the burr from the pipe is also provided.

The rear chuck is provided with three independent jaws with which fittings can be made up, and also a bushing for holding the pipe central without gripping the pipe.

The drive is from a four-step cone pulley at the back, which in connection with compound shifting gears affords eight changes of speed. The machine can be arranged to be driven by belt or motor. An automatic oil pump in the bed of the machine supplies oil to both the dies and the cutting-off tool.

The machine illustrated occupies a floor space of 50 x 120 in., and weighs in the neighborhood of 7,500 lb. Ten other sizes of the machine are made, ranging in pipe capacities from 1¼ to 6 in. in diameter, inclusive.

Front End Netting for English Locomotives.—Smokestacks of locomotives in Great Britain are not supplied with screens to prevent the emission of sparks and big burning cinders. Such a device is used, however, for traction engines employed for agricultural purposes. Complaints of burning cinders have been very numerous this year, and it is suggested that the English railway managers should immediately adopt spark arresters, such as are used in the United States.—*Industrial World.*

Frank Thomson Scholarships.—A fund of $120,000 has been deposited with a trust company which will act as trustee, the income of which will be used to furnish scholarships of $600 a year each, open only to sons of employees of the Pennsylvania Railroad. Competitive examinations will be held, the winners of which, if satisfactory in other ways, can attend any college or technical school desired. Two men will be chosen this year, two more the following year, etc., finally making eight men who will be kept in college by this fund.

Cost of Locomotive Operation.—In a contributed discussion on the subject of "Electric vs. Steam Locomotive," printed in the March proceedings of the Amer. Inst. Elect. Engineers, Mr. W. S. Murray gives some figures obtained from tests and records of freight and passenger locomotives operating on the New York division of the New York, New Haven & Hartford R. R. It is shown that in express passenger service the average pounds of coal per indicated horse-power hour was 4.06 and in local passenger service it was 4.68. This includes all the coal burned divided by the total horse-power hours for 18 days' service, these being based on the average horse-power obtained from careful tests over the division. The number of pounds of coal per revenue ton mile for express, local and freight trains is .194, .335 and .169 respectively. The cost of repairs for freight engines, which apparently covers about 10 locomotives for one year, was 6.68 cents per mile and the cost of maintenance is 1.42 cents per mile, giving 8.1 cents per mile total for repairs and maintenance. The figures for passenger locomotives are 3.88 cents repairs, 1.72 cents maintenance and 5.6 cents total. Mr. Murray concludes that, "for mixed freight and passenger service the same gross draw-bar pull can be produced by the single-phase method of traction for 60 per cent. of the coal required by the steam method of traction," and that, "locomotive repairs are between three and four times as great for steam as for electric locomotives." The source of the figures for electric traction are not given.

IMPROVED HOSE CLAMP.

The accompanying illustration shows a new and improved clamp for air, water or steam hose, which has been designed and patented and is being manufactured by the Thompson Manufacturing Company, Newark, Ohio. It will be seen that this clamp can be made of heavier material than is commonly used, because it does not have to be sprung apart in order to be placed over a hose, the fittings of which are already in place. It is made of three parts, of which the connecting bolt forms one, the two parts of the clamp being interlocked, as is clearly shown in the illustration. It is easily evident that the larger section of the clamp can be slipped over the hose without injury to either and the smaller piece then hooked into place, resulting in a clamp which can be drawn up very tightly without danger of breakage. It can, of course, be removed without deforma-

IMPROVED HOSE CLAMP.

tion and hence is practically indestructible. These clamps are made in sizes from ½ in. steam hose to 3½ in. tank hose and are made of galvanized cold rolled steel.

PERSONALS

Mr. G. W. Mudd has been appointed master mechanic of the Denver & Rio Grande Railway at Alamosa, Colo.

Mr. W. R. Davis has been appointed road foreman of engines of the Toledo & Ohio Central Railway at Columbus, Ohio.

Mr. J. D. Crawley has been appointed master mechanic of the Georgia, Florida & Alabama Railway, with office at Bainbridge, Ga.

Mr. C. P. Diehr has been appointed master mechanic of the New York Central & Hudson River Railroad, with office at Avis, Pa.

Mr. Tabor Hamilton has been appointed master mechanic of the Cumberland Valley Railroad, at Chambersburg, Pa., succeeding Mr. J. B. Divens.

Mr. Walter E. Hooton has been appointed chief clerk of the motive power department of the Santa Fé Central Railway at Estancia, New Mexico.

Mr. Henry C. Manchester has been appointed assistant superintendent of motive power of the Maine Central Railroad, with office at Portland, Maine.

Mr. J. R. Donnelly has been appointed superintendent of motive power of the Canada Atlantic Ry. (Grand Trunk System), with office at Ottawa, Ont.

Mr. W. Kennedy has resigned as master mechanic of the Grand Trunk Railway, at Toronto, Ont., to accept a position with the Great Northern Railway.

Mr. R. L. Stewart has been appointed master mechanic of the Kansas City Southern Railway, with office at Pittsburg, Kan., succeeding Mr. W. B. Dunlevy.

Mr. F. Burke has been appointed general foreman of shops ot the Toledo & Ohio Central Railway, at West Columbus, Ohio, succeeding Mr. W. R. Davis.

Mr. Bert Myers has been appointed acting road foreman of engines of the Erie Railroad at Huntington, Ind., in place of Mr. J. A. Cooper, transferred.

Mr. A. C. Adams has been appointed master mechanic of the Pennsylvania Division of the Lehigh Valley Railroad, with office at Sayre, Pa., succeeding Mr. John McMullen.

Mr. J. B. Diven has been appointed assistant engineer of motive power of the New Jersey grand division of the Pennsylvania Railroad, with headquarters at Jersey City, N. J.

Mr. W. F. Girten has been appointed general storekeeper of the Central Railroad of New Jersey, with headquarters at Elizabethport, Pa., succeeding Mr. H. S. Hoskinson, resigned.

Mr. David M. Perrine has been appointed superintendent of motive power of the new Western Pennsylvania Division of the Pennsylvania Railroad, with headquarters at Pittsburg, Pa.

Mr. George Donahue has been appointed master car builder of the New York, New Haven & Hartford Railroad, with office at Readville, Mass., succeeding Mr. F. D. Simpson, resigned.

Mr. P. Z. Zang has been appointed master mechanic of the Worcester Division of the New York, New Haven & Hartford Railroad, with office at Providence, R. I., succeeding Mr. Donahue.

Mr. D. M. Wallace has been appointed to succeed Mr. Perrine as superintendent of motive power of the Philadelphia and Erie Railroad Divison of the Pennsylvania Railroad, with headquarters at Williamsport, Pa.

Mr. L. J. Miller, division foreman of the Missouri Pacific Ry., at Atchison, Kan., has been appointed master mechanic of the northern Kansas and Omaha divisions, excepting the Kansas City Northwestern R. R., with office at Atchison, Kan.

Mr. W. G. Wallace has been appointed to the new office of superintendent of motive power of the Detroit, Toledo & Ironton Railroad and the Ann Arbor Railroad, with headquarters at Toledo, Ohio. The office of master mechanic of these roads has been abolished.

Mr. A. J. Cromwell, for many years superintendent of motive power of the Baltimore & Ohio Railroad, and an important factor in locomotive building, died at Baltimore, April 9, at the age of 76 years. Mr. Cromwell entered the company's employ 45 years ago as a machinist and rose in the ranks until he became head of the motive department. He designed many improvements for locomotives and planned the engines which established the 45-minute schedule between Baltimore and Washington. He retired several years ago.

Mr. W. J. Tollerton, formerly superintendent of motive power of the Chicago, Rock Island & Pacific Railroad at Topeka, Kan., has been appointed to the new office of assistant general superintendent of motive power. In connection with this appointment Mr. J. B. Kilpatrick has been appointed superintendent of motive power of the Central District, with headquarters at Chicago; Mr. W. J. Harrison has been appointed superintendent of motive power of the Northern District, with office at Cedar Rapids, Ia.; Mr. S. W. Mollinix has been appointed superintendent of motive power of the Southwestern District, with office at Topeka, Kan.; Mr. C. M. Taylor has been appointed superintendent of motive power of the Choctaw District, with headquarters at Shawnee, Okla., and Mr. F. W. Williams has been appointed superintendent of motive power of the Southern District, with office at Ft. Worth, Texas. The superintendents of motive power will report to the assistant general superintendent of motive power and will make such reports and perform such duties as are required by the general superintendent of motive power and will be subject to the direction of the latter in matters of shop practice, standard plans, etc. The assistant general superintendent of motive power will report to the general manager.

BOOKS

Mineral Resources of the United States.—U. S. Geological Survey Report for the calendar year 1905. Government Printing Office, Washington, D. C.

This report covers over 1,400 pages, giving an immense amount of valuable and accurate information concerning the mineral resources of the United States. The larger part of the book deals with coal and oil, on which subjects complete statistical data of all kinds, as well as much general information, including anaylsis of many different samples, are given.

The Theta-Phi Diagram. Applied to Steam, Gas and Oil Engines. By Henry A. Golding, A. M. I. Mech. E., 123 pages. 5 x 7 in. Cloth. Published by the Technical Publishing Company and issued through D. Van Nostrand Co., 23 Murray St., New York. Price, $1.25.

This is the second edition of this book, first issued in 1898, in which the author stated that "of the utility of the temperature-entropy diagram, in representing the various thermal changes which take place in all heat motors, there cannot be any doubt." The author has presented the subject with as little mathematics

as possible, largely using the graphical method by means of which the principles are much more simply explained. In brief, the Theta-Phi diagram is of value for representing the thermal changes which take place in all heat engines and can be very easily represented graphically as well as mathematically. The indicator diagram is a rough example of this class of diagram, although it does not show the reception and distribution of all the heat. This book will be found to explain the subject and the practical value of the diagrams very clearly.

Locomotives: Simple, Compound, and Electric. By H. C. Regan. Fifth Edition. 917 pages. 5½ x 8 in. Cloth. Published by John Wiley & Sons, 43 E. 19th St., New York. Price, $3.50.

The last edition of this well-known and valuable book on locomotives has been revised to bring the subject strictly up to date. Much matter on the electric locomotive has also been added. The principles of generating and transmitting apparatus and method of application have been explained. In brief, the book is a practical treatise of the locomotive engine and its operation. The subject has been carefully sub-divided, each part being handled separately, and questions and answers given in connection with each chapter. It includes a large amount of matter in reference to the proper method of procedure following any conceivable accident, as well as the most satisfactory and approved method of operation under different conditions. The book can be highly recommended to anyone making a study of the locomotive, either as a student or in preparation for improved practical work.

CATALOGS.

The Machine Tool and the Motor.—The Northern Electrical Manufacturing Company, Madison, Wis., is issuing a small folder showing examples of modern practice in the application of electric motors to machine tools of different kinds.

Spring Painting.—The Joseph Dixon Crucible Company, Jersey City, N. J., is issuing a leaflet on the above subject, drawing attention to the value of graphite paint as a preservative for both metal and wood. This paint can be obtained in several different colors.

Electrical Apparatus.—The General Electric Company is issuing Bulletins Nos. 4,496 and 4,393C, the former on electric pumping plants and the latter on moderate speed engine driven revolving field alternators. The same company is also issuing a very attractive catalog on the subject of fan motors. It covers this type of apparatus very completely, showing several new arrangements.

Book Catalog.—The Hill Publishing Company, 505 Pearl street, New York, announces that the book departments of the *Engineering and Mining Journal, Power* and the *American Machinist* have been consolidated and the business will hereafter be transacted under the name of the Hill Publishing Company, Book Department. A catalog is being issued of a large number of books which it is now prepared to furnish on short notice. This covers works on mechanical, mining, and electrical engineering and allied subjects.

Electric Generating Sets.—By the issue of bulletin No. 143 entitled "Generating sets with horizontal engines," the B. F. Sturtevant Company, Hyde Park, Mass., completes its group of publications in its engineering series relating to engines and generating sets. These now comprise one bulletin each covering the following subjects: vertical enclosed engines, horizontal center crank engines, vertical compound enclosed engines, and one bulletin each descriptive of generating sets equipped respectively with each of the above types of engines.

Conveying Machinery.—The Jeffrey Manufacturing Company, Columbus, Ohio, is issuing an illustrated supplement of the Jeffrey Conveying Machinery for saw mills, lumber mills and wood-working industries. This shows chain and wire rope conveyors for timbers of all shapes and sizes, as well as wood refuse varying from sawdust to slabs. Package conveyors for handling material of almost any nature, in several different designs, are also shown in the same catalog. The illustrations show many interesting adaptations of this equipment in operation.

Centrifugal Pumps.—R. D. Woods & Company, Philadelphia, is issuing a catalog which illustrates and describes many different designs of centrifugal pumps for water works and high pressure fire service. This type of pump is becoming very popular for many services which have been previously considered as suitable only for reciprocating pumps. This company has given the subject much careful attention and study and is prepared to build centrifugal pumps of practically any size for any purpose to which they are suited. The catalog shows pumps both vertical and horizontal, direct connected or belted to electric motors, steam or gas engines. A practical and economical plant can be obtained with a gas engine using gas from a producer, all of which equipment can be furnished by this company. A recent test of a producer plant of this type showed that it was possible to obtain 20 h. p. for one cent per hour. The catalog contains many interesting figures, which have been obtained by tests of gas engine and other types of pumping plants. Brief descriptions are given of the high pressure fire service plants of several of the larger cities, in which multiple-stage centrifugal pumps are employed.

Mogul Type Freight Locomotives.—A pamphlet recently issued by the American Locomotive Company, is the seventh of the series which is being published by this company to include the various standard types of locomotives. As the title indicates, this pamphlet is devoted to the mogul type of locomotive, and illustrates and describes twenty-five different designs of this type built for various railroads. The designs illustrated range in weights from 49,000 to 187,000 pounds, with hauling capacities adapted to a variety of road and service conditions, and the pamphlet as a whole constitutes a very complete record of the production of the company in this type of locomotive.

NOTES

Morgan Engineering Company.—The above company, the main office of which is at Alliance, Ohio, announces that it has opened an eastern office at 111 Broadway, New York, of which Mr. E. J. Parker is manager.

Standard Coupler Company.—The above company announces the removal of its general offices from 160 Broadway to the sixteenth floor of the United States Express Building, Trinity Place and Rector street, New York City.

American Steam Gauge & Valve Manufacturing Company.—Mr. Gardner Cornett, of Providence, R. I., has recently been elected vice-president of the above company, his office being located at the headquarters of the company, No. 220 Camden street, Boston.

Crocker-Wheeler Company.—This company has recently been obliged to establish an office at Birmingham, Ala., which is located in the Woodward Building, and will be in charge of Mr. B. A. Schroder, who heretofore has been in charge of the New Orleans territory.

French Representative at the Foundrymen's Exhibition.—It is announced that M. Ronceray will represent Ph. Bonvillain & E. Ronceray, machine tool importers and manufacturers of moulding machines, at the American Foundrymen's Association exhibition to be held in Philadelphia, May 20 to 24. Following the exhibition he will visit the principal machine tool manufacturers for the purpose of making arrangements to handle a line of machines in Europe.

Joseph Dixon Crucible Company.—At the annual meeting of the stockholders of the company the old board of directors were unanimously re-elected. At the meeting of this board of directors the former officers were re-elected as follows: Mr. E. F. C. Young, president; Mr. John A. Walker, vice-president and treasurer, and Mr. George E. Long, secretary. Judge J. D. Bedle was also re-elected as counsel. There were 6,460 shares, out of a total of 7,345 shares, represented at the meeting.

Niles-Bement-Pond Co.—On May 1 the Chicago branch of the above company will move to its new offices on the sixth floor of the new Commercial National Bank Building, at the corner of Clark and Adams streets. The Pratt & Whitney Company will abandon its present show room and offices and will combine its machinery sales department with that of the Niles-Bement-Pond Company. The show room and stock of the Pratt & Whitney Company will be located on the ground floor of the new Plamondon Building, corner of Clinton and Monroe streets.

Cincinnati Planer Company.—This company has now broken ground for its new plant at Oakley, Ohio, a suburb of Cincinnati, where an eight acre tract of ground has been secured. The present plans include the building of two buildings of modern construction, measuring 140 by 200 feet each, on completion of which the company will move to its new location. Several other well known manufacturers, including the Cincinnati Milling Machine Company, the Bickford Drill & Tool Company and the Triumph Electric Company are also locating in the same vicinity. A central power station owned by these four concerns will furnish heat, light and power for all of the plants.

American Locomotive Company's Exhibit at Jamestown.—The American Locomotive Co.'s exhibit at the coming Jamestown Exhibition will occupy a plot of 100 by 250 feet in the southern portion of the grounds on the southeasterly side of Lee's Parade grounds. The exhibit will be housed in a building especially constructed for the purpose, 177 feet long and 20 feet wide, with the entrance facing the parade. The exhibit will consist of one consolidation type locomotive built for the Southern Railway with 22 by 30 inch cylinders and slide valves operated by the Walschaert valve gear; a Pacific type passenger locomotive built for the Chesapeake & Ohio Railway with 22 by 28 inch cylinders and piston valves; a 10 by 16 inch saddle tank contractor's locomotive, and a Class 44-16-2½ Atlantic steam shovel. The steam shovel will be placed outside of the building and will be in operation under its own steam.